

Proceedings of the NASA Health Physics Conference

**June 6-10, 2005
Cocoa Beach, FL**

Guy Camomilli, MPH, CSP, CHMM
Office of the Chief Health and Medical Officer



Conference Agenda

Monday, June 6

Travel Day

- 3:00 – 6:00 **Registration Desk Open**
- 6:00 – 9:00 **Informal Reception / Hors d' Oeuvres**
Hosted by Office of the Chief Health and Medical Officer

Tuesday, June 7

- 7:00 – 7:45 Continental Breakfast
- 7:45 – 8:00 Welcome and Orientation
- 8:00 – 9:30 **Nonionizing Radiation Safety Updates and Hot Topics**
Tim Hitchcock, CIH/CLSO, president of LightRay Consulting
This four-hour training course will address the nonionizing radiation spectral region including ultraviolet radiation (UVR), radio-frequency radiation (RFR), extremely low frequency fields (ELF), and lasers. Specific topics will include, but not be limited to: new and/or revised safety standards in laser safety, RFR, and ELF; results of most recent studies on cell phones and cancer; and the use of ultraviolet germicidal irradiation in heating, ventilating, and air conditioning equipment in federal government buildings.
- 9:30 – 9:45 Coffee Break
- 9:45 – 12:00 **Nonionizing Radiation Safety Updates and Hot Topics (Continued)**
- 12:00 – 1:00 Lunch Break
- 1:00 – 5:00 **Technical Tour**
A technical tour Kennedy Space Center (KSC) will consist of an orientation of the Non Destructive Evaluation (NDE) computerized tomography (CT) system utilized at KSC. The tour will also include a stop at Innovative Science and Technology Experimentation Facility (ISTEF) which operates a high-powered class IV laser in support of the nation's defense program. The next part of the tour will cover the Radiation Safety Office's role in a radiological WMD response scenario and in support of a major radiation source launch. The tour will conclude with a visit to the Orbital Processing Facility and a close up view of a shuttle orbiter with a discussion of laser applications.

Wednesday, June 8

7:00 – 7:45	Continental Breakfast
7:45 – 8:00	Days Logistics and Announcements
8:00 – 9:45	Radioactive Materials Shipping Regulations Al Grella, CHP A presentation on Department of Transportation and Nuclear Regulatory Commission regulations for shipping radioactive materials relevant and useful to the NASA health physicists attending will cover at a minimum, requirements for making Type A and excepted quantity shipments, recent regulatory changes, creation/retention shipping papers, and lessons learned.
9:45 – 10:00	Coffee Break
10:00 – 12:00	Radioactive Materials Shipping Regulations (Continued)
12:00 – 1:00	Lunch Break
1:00 – 3:00	Proposed Agency Health Physics Policy Guy Camomilli, MPH, CSP, CHMM Agency Radiation Safety Officer Office of the Chief Health and Medical Officer
3:00 – 3:15	Coffee Break
3:15 – 5:00	Open Discussion: Center Issues and Agency Initiatives

Thursday, June 9

7:00 – 7:45	Continental Breakfast
7:45 – 8:00	Days Logistics and Announcements
8:00 – 9:45	SAM 935 Refresher Training Michael Murray, P.E. Classroom and hands-on training will provide refresher and advanced concepts directed at the user's needs relevant to the BNC SAM 935 portable gamma spectroscopy system. The training experience will achieve maximum benefits to health physicists performing routine operational use as well as emergency response, instrument calibration, report generation, and identification of unknown radioactive materials.
9:45 – 10:00	Coffee Break
10:00 – 12:00	SAM 935 Refresher Training (Continued)

12:00 – 1:00	Lunch Break
1:00 – 2:45	Radiation Protection Program Management: Perspectives of an NRC Regulator Joseph DiCicco, Health Physicist Office of Nuclear Materials Safety and Safeguards Division of Industrial and Medical Nuclear Safety
2:45 – 3:00	Coffee Break
3:00 – 5:00	Radiation Protection Program Management (Continued)
6:00 – 10:00	Technical Tour -- Outdoor Laser Safety Next to medical laser applications, the laser entertainment industry is probably the most heavily regulated of all laser operations. This behind the scenes technical tour will cover the radiation safety aspects of outdoor laser use and compliance with Federal Aviation Association regulations associated with a major outdoor laser program. Disney EPCOT Center, Orlando, FL

Friday, June 10

7:00 – 7:45	Continental Breakfast
7:45 – 8:00	Days Logistics and Announcements
8:00 – 8:45	Pluto New Horizons Mission Support Randall (Randy) Scott, Radiation Protection Officer Kennedy Space Center
8:45 – 9:30	Outdoor Laser Safety at Langley Research Center Kim Merritt, Radiation & Laser Safety Officer Langley Research Center
9:30 – 9:45	Coffee Break
9:45 – 10:30	Unitary Plan Wind Tunnel 9X7 Sectional Accidental Laser Activation Close Call William Vermeere, Radiation Safety Officer NASA Ames Research Center
10:30 – 11:00	Laser Safety Officer Certification Process and Standards Updates Gus Anibaro Laser Institute of America
11:00 – 11:30	Meeting Wrap-Up and Closing Remarks Guy Camomilli, MPH, CSP, CHMM, Agency Radiation Safety Officer Office of the Chief Health and Medical Officer

TRAVEL HOME SAFELY



March 25, 2005

TO: NASA Center Environmental Health COTRs
NASA Center Medical COTRs

FROM: Chief Health and Medical Officer

SUBJECT: NASA Health Physics Conference

The Office of the Chief Health and Medical Officer is holding a NASA Health Physics Conference at the Double Tree Hotel in Cocoa Beach, Florida on **June 6-10, 2005**. The last Agency wide Health Physics Meeting was held in 2000 in Annapolis, Maryland. This Conference will provide the means to exchange scientific and technical data and management experiences and would be valuable to environmental health professionals who have ionizing or nonionizing radiation safety job responsibilities at NASA Centers and Facilities.

The agenda will include three training events:

- Tim Hitchcock, CIH, CLSO, and president of LightRay Consulting will provide nonionizing radiation safety training
- Michael Murray, P.E., will provide training on the SAM 935 portable gamma-ray spectrometer; and
- Al Grella, CHP, will provide training on regulations pertaining to shipping radioactive materials.

In addition, an inspector with the Nuclear Regulatory Commission will address compliance issues and a special session will be held to discuss proposed Agency policy on health physics. Technical tours will include Kennedy Space Center radiological operations and Disney's outdoor laser safety program in Orlando.

I encourage every NASA Center and Facility to have representation at the Conference. It will be a great opportunity for the NASA health physics community to receive quality training and share information and experiences. Of particular interest will be the opportunity to provide input into the Agency health physics policy. Below are important details and dates to be considered in planning your attendance.

- Additional details about the conference can be found at the NASA Occupational Health website at http://ohp.nasa.gov/conference_info/2005/hpconf/index.html.

- Registration must be completed via the NASA Occupational Health website by 12:00 noon on **June 3**.
- You can call the hotel directly to reserve your room (1-800-552-3224) and specify the *2005 NASA Health Physics* group rate. If you book your air and hotel reservations through CI Travel, tell the agent that rooms have been reserved at the Doubletree at a special rate so that he/she will call the hotel and get that discount rate of \$103 + tax. **May 16** is the last day to get the special hotel rate for the Conference and rooms are reserved on a first-come, first-served basis.

This memo is being sent via hardcopy and also via e-mail to ensure timely delivery to all who might be interested in attending the Conference. If you have questions about the meeting, please contact Guy Camomilli at 321-867-1417 (guy.camomilli-1@ksc.nasa.gov) or Janine Scoville at 321-867-2961 (janine.scoville-1@nasa.gov).



Richard S. Williams, MD, FACS

cc:

NASA Radiation Safety Officers

NASA Environmental Health Managers

Nonionizing Radiation Safety: Updates and Hot Topics

R. Timothy Hitchcock, CIH, CLSO
LightRay Consulting
Cary, North Carolina





Topics To Be Addressed

- Ultraviolet Radiation
 - UVGI in AHUs
- Laser Radiation
 - Standards update
 - ANSI Z136
 - IEC 60825
 - A quiet revolution
- Radio-frequency Radiation
 - Standards update
 - IEEE C95.1
 - IEEE C95.7
 - Measurement of RF
 - Cell phones & cancer
 - Update on brain cancer epidemiology



Topics To Be Addressed

- Extremely low frequency fields
 - Standards update
 - IEEE C95.6-2002

Characterization of Nonionizing Radiation

Spectral Region	Wavelength	Frequency
Ultraviolet	100 - 400 nm	----
Visible	400 – 700 nm	----
Infrared	700 nm – 1 mm	----
Radio-frequency	----	300 GHz – 3 kHz
ELF	----	3 kHz – 0 Hz



Quantities & Units

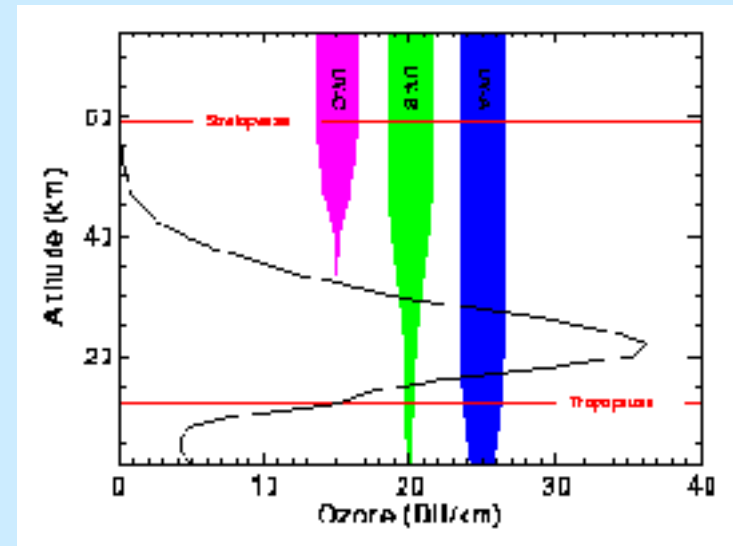
- Used in nonionizing radiation exposure limits
- Many quantities because of different spectral regions and interaction mechanisms
- Legend for following table:
ampere = A; centimeter = cm; joule = J;
meter = m; milliampere = mA; milligauss = mG;
microtesla = μ T; volt = V; watt = W

Quantities Used in Exposure Evaluation

<u>Spectral Region</u>	<u>Quantity</u>	<u>Unit</u>
UV, IR & Lasers	Irradiance (E)	mW/cm ² ; μW/cm ²
	Radiant exposure (H)	J/m ² ; mJ/cm ²
Radio-frequency	E-field strength (E)	V/m; V ² /m ²
	H-field strength (H)	A/m; A ² /m ²
	Power density (S, W)	mW/cm ²
	Specific absorption rate	W/kg
	Specific absorption	J/kg
	Induced/contact currents	mA
ELF	E-field strength	V/m; kV/m
	Magnetic-flux density (B)	μT, mG
	Current density (J)	mA/m ²
	<i>In situ</i> E field	V/m

Overview UV Radiation

- Subdivided into
 - UV-C 100 – 280 nm
Germicidal region
 - UV-B 280 – 320 nm
Erythematous region
 - UV-A 320 – 400 nm
Blacklight region
- Wavelengths ≥ 295 nm
at Earth's surface





UV – Health Effects

- ❑ Target organs: eyes, skin, immune system
- ❑ Ocular effects
 - Photokeratoconjunctivitis – welder's flash
 - Cataracts
- ❑ Skin effects
 - Erythema – photochemical skin burn
 - Photosensitivity – combined exposure
 - Skin cancer – NMSC & malignant melanoma

UVGI in AHUs

- ❑ Uses low-pressure Hg vapor lamps
- ❑ Lamps emit most radiant energy at 253.7 nm
- ❑ 253.7 nm approaches maximum of DNA absorption spectrum
- ❑ Used since late 1920's to treat room air in an attempt to kill microorganisms





GSA Requires UVGI in AHUs

- “Ultraviolet light (C band) emitters/lamps shall be incorporated downstream of all cooling coils and above all drain pans to control airborne and surface microbial growth and transfer. Applied fixtures/lamps must be specifically manufactured for this purpose. Safety interlocks/features shall be provided to limit hazard to operating staff.”

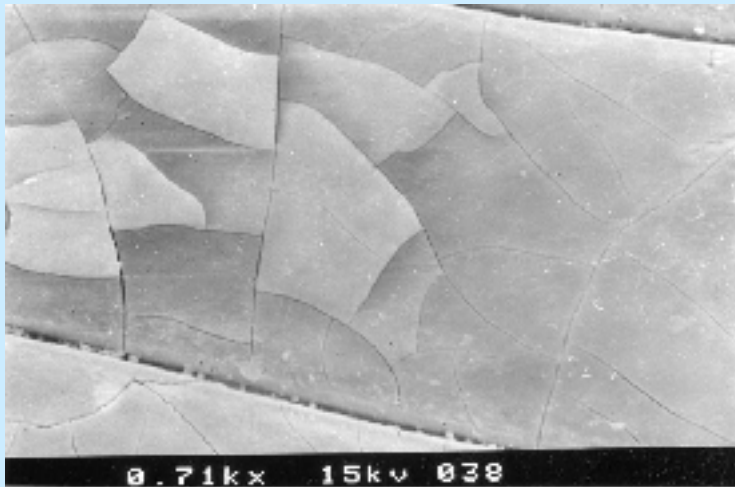
Facilities Standards for the Public Building Service; ch. 5.9, p. 143.

UVGI in AHUs – Does it Work?



- Effectively treats microorganisms on stationary surfaces
 - Interior panels, insulation, drip pans
- Appears to have little effect on airborne microorganisms, esp. spores and health of building occupants

UVGI – The Down Side ...



Electromicrograph of UV-induced crazing of polycarbonate.

- Adversely effects polymeric materials
 - Electric wiring, isolation dampers, gaskets, bushings, drive belts, thermal insulation, fasteners, ties, grommets
- Materials are not qualified for use with UV
- Limited tests found degradation of 13/19 materials tested for 12 months

UVGI – The Down Side ...


- Effects on human health
 - Target groups: those who install, operate and maintain AHUs
 - HVAC personnel of many companies unaware of UV health hazards
 - Possible ozone exposure
 - Possible mercury contamination/exposure



Laser Radiation

- Spectral region: 180 nm to 1 mm
- Includes: UV, visible & IR
- Temporal operation
 - Continuous wave (CW): ≥ 0.25 s
 - Pulsed: < 0.25 s; as short as 4 fs
- Targets: skin & eyes






Laser Radiation – Standards Update

- Newly published
 - ANSI Z136.4-2005, *Recommended Practice for Laser Safety Measurements for Hazard Evaluation*

- Recently revised & republished
 - ANSI Z136.3-2004, *Safe Use of Lasers in Health Care Facilities*



Laser Radiation – Standards Update

- Standards in revision
 - ANSI Z136.2-1997 – *Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources*
 - ANSI Z136.5-2000 – *Safe Use of Lasers in Education Institutions*

Laser Radiation – Standards Update

- Standard in development
 - Z136.7 – *Eyewear and Protective Barriers*



Laser Radiation – Standards Update



Image: Univ. of TX

- Standards recently passing committee draft for vote (CDV) stage:
 - ANSI Z136.1, *Safe Use of Lasers*
 - ANSI Z136.6, *Safe Use of Lasers Outdoors*



Revised ANSI Z136.1

- ❑ New classification scheme
- ❑ More information on alignment procedures
- ❑ Recommend medical surveillance
- ❑ Reorganization of non-beam hazards section
- ❑ Stress dual limits (MPEs) where applicable
- ❑ Normative appendix – Appendix A
- ❑ Index



ANSI Z136.1

- New classification scheme
 - Classification - numerical scheme used to group lasers on basis of optical power & potential hazard
 - Harmonized with international standard, IEC 60825-1

New Classification Scheme

<u>US FDA</u>	<u>Existing ANSI Z136.1</u>	<u>Revised ANSI Z136.1</u>
I	1	1
---	---	1M
IIa	(1)	(1)
II	2	2
---	---	2M
IIIa	3a	3A
IIIb	3b	3B
IV	4	4

Low irradiance beams

ANSI Z136.1



- Most hazardous activity with lasers
 - ~1/3 of all reported accident exposures
 - ~60-70% of accidents in laboratories
- Standard recommendations now included in body of standard as well as Appendix



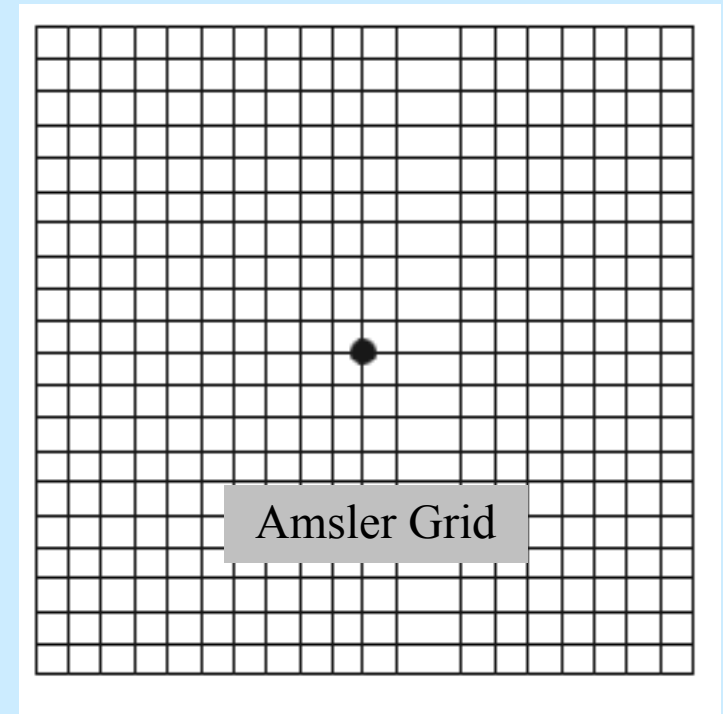
ANSI Z136.1 – Medical Exams

- ❑ Changed from requirement to recommendation for screening
 - “...should be required for Class 3B and 4 lasers and laser systems.”

- ❑ Maintained as requirement for exams following suspected exposure or injury

ANSI Z136.1 – Medical Exams

- Motivated by Professor John Marshall
 - 38-y history of exams in UK
 - All laser-induced damage self reported
 - No damage determined through screening
- Similar experience in US





ANSI Z136.1

- Reorganization and expansion of non-beam hazards section
 - Physical agents
 - Chemical agents
 - Biological agents
 - Human factors



Dual Limits - MPEs

- Dual limits refers to spectral regions where both thermal and photochemical effects occur.
- Reorganization of MPE table to stress dual limits:
 - Table 5a – Ocular exposure to point source beams
 - UV & visible (400-500 nm) λ
 - Table 7 - Skin exposure – UV λ

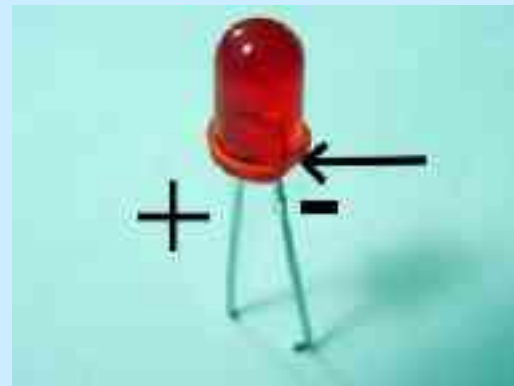


Normative Appendix

- All appendices were Informative
 - Not part of the standard
- New Appendix A is Normative
 - Part of the standard
 - Addresses laser safety programs & duties of the LSO (moved from Section 1.3)
 - Section 1.3 includes laser safety program provisions

International Standards Activity

- IEC TR 60825-14 – *Safety of laser products – Part 14: A user's guide*
- IEC 60825-1- Proposal to change scope to remove LEDs which are currently defined as lasers





A Quiet Revolution

- Used to be that lasers emitted a single wavelength ...
- Then, along came harmonic generation
 - 1961: Ruby @ 694.3 nm → Quartz crystal → 347.2 nm
 - Nd:YAG @ 1064 nm → KTP crystal → 532 nm
- Based on nonlinear optical properties of crystals.



Nonlinear Optical Crystals

- ❑ Nonlinear: $I_o \neq I \times k$
- ❑ Transparent crystals
 - KTP – potassium titanyl phosphate
 - BBO – beta barium borate
 - LBO – lithium triborate
 - KTA – potassium titanyl arsenate
 - Others



Nonlinear Optical Crystals

- Used to generate harmonics
 - Sum frequency generation – adds two low-energy photons to emit one high-energy photon
 - $(1/1064 + 1/532 \rightarrow 1/355 \text{ nm})$
 - Frequency doubling – $\frac{1}{2} \lambda$; $2x f$
 - Optical parametric generation – splits one high-energy photon to emit two low-energy photons
 - Other processes ...



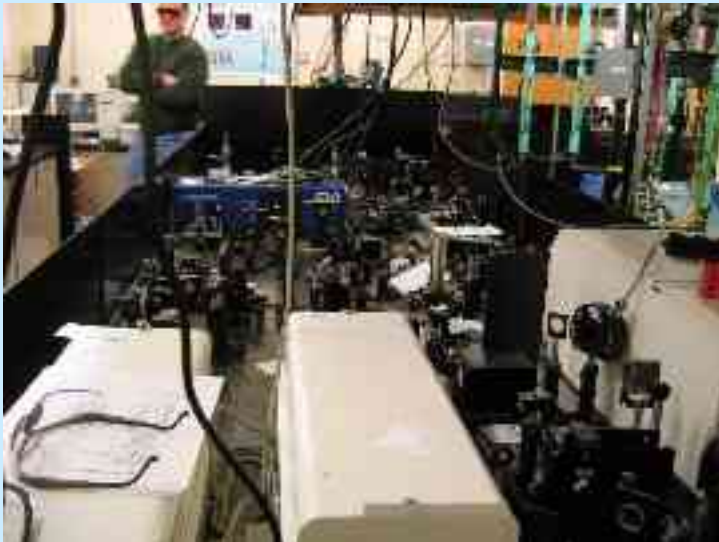
Devices Containing NLO Crystals

- These, and other processes, have given rise to
 - Optical parametric oscillators (OPO)
 - Optical parametric amplifiers (OPA)

- Often utilize Ti:sapphire as gain medium

Resulting in ...

- ❑ Broadband tunable laser output
- ❑ TOPA can be tunable from 290 nm to 20,000 nm
- ❑ Complicates laser safety





Overview of Radio-frequency Radiation

- Spectral region: 3 kHz to 300 GHz
 - Microwaves: 300 MHz to 300 GHz
 - Radio-waves: 3 kHz to 300 MHz

- Primary OEL: IEEE C95.1, 1999 Ed.



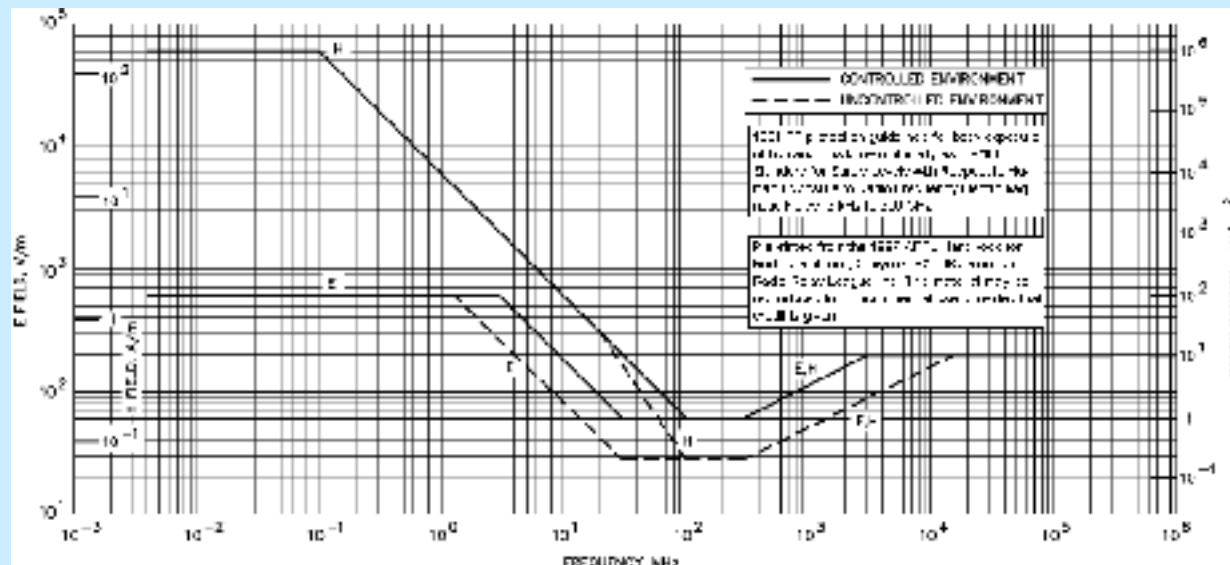


Overview of RFR – Health Effects

- Biological basis of exposure guidelines
 - Reversible behavior disruption in test animals
- Other effects observed consistently in test animals include:
 - Cataracts
 - Reproductive & developmental effects
 - Threshold effects (high local or WBA SARs)
- Human studies often equivocal

RF Radiation – Standards Update

- Standards in revision
 - IEEE C95.1, 1999 Ed. – *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*





Some definitions ...

- Electrostimulation – induction of a propagating action potential on excitable tissue (e.g., nerve or muscle) by an applied electrical stimulus
- Maybe direct or indirect electrostimulation



Continuing those definitions ...

- ❑ Direct electrostimulation via internal E field induced by external E or H fields without direct contact with conductors or spark discharge.
- ❑ Indirect electrostimulation through contact with a conducting object under the influence of the E or H field, including spark discharge.



Electrostimulation: Bioeffects

- ❑ Aversive or painful stimulation of sensory or motor neurons
- ❑ Muscle excitation leading to injury
- ❑ Cardiac excitation
- ❑ Excitation of neurons or direct synaptic activity within the brain



IEEE C95.1 (Draft)

- ❑ Basic restriction for electrostimulation changed from current density to *in situ* electric field
- ❑ 3 kHz to 5 MHz - *in situ* electric field
- ❑ Consistent with IEEE C95.6-2002



IEEE C95.1 (Draft)

- Presents 2 separate rules for controlling exposure and redefines frequency range for:
 - Electrostimulation – 3 kHz to 5 MHz
 - Thermal effects – 100 kHz to 300 GHz
 - Transition region – 100 kHz to 5 MHz

- Transition region requires independent evaluation for both rules

IEEE C95.1 (Draft)

- Transition region: Hypothetical exposure assessment (assume 1 MHz source)

	<u>Thermal</u>	<u>Electrostimulation</u>
Field strength	1843 V/m 16.3/F _m A/m	1842 V/m 490 A/m
Induced/contact Currents (1 foot)	100 mA	1.00F _k mA
Averaging time	6 min	0.2 sec

IEEE C95.1 (Draft)


- Two tier MPEs
 - General public
 - Controlled environment
 - Action level
- Exposure $>$ action level requires a radio-frequency safety program (RFSP)



IEEE C95.1 (Draft)

- SAR for extremities
 - Pinna included with extremities
 - Based on studies with cell phones where relatively high SAR occurred in pinna
- WBA-SAR applicable upper boundary reduced from 6 GHz to 3 GHz
- Increase spatial-peak SARs





IEEE C95.1 (Draft)


- Increase in E-field MPE – controlled environment
 - 100 kHz – 3 MHz: 1842 V/m
 - Was 614 V/m which is now the action level

- Appendix includes extensive literature review of bioeffects

RF Radiation – Standards Update

- Standard completing committee draft for vote (SCDV) stage:
 - IEEE C95.7 –
Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz





IEEE C95.7 (Draft)

- ❑ Basis of a RF safety program (RFSP)
- ❑ Establishes action level
 - Lower tier of IEEE C95.1 standard
 - ICNIRP general public guidelines
 - 1/5th ACGIH TLVs
 - FCC uncontrolled/general public limits



Elements of RFSP (Draft)

- ☐ Written policy or operating procedure
- ☐ Name RF safety officer, RFSO
- ☐ Inventory Sources
- ☐ Perform exposure assessment
- ☐ Categorize work locations

RFSP Categories (Draft)

RFSP Category	Exposure Condition	Control Actions Required
1	Action level not exceeded.	None, unless maintenance or other conditions alter category.
2	Exposure limit not exceeded.	Various.
3	Potential to exceed OEL.	Various.
4	OEL will be exceeded.	Restrict source output to achieve category 3, 2, or 1 or prevent access.



IEEE C95.7 (Draft)

- RFSP not required for Category 1 if
 - Levels < action level during operation, maintenance or service
 - RFSO not required

- RFSP necessary for Category 1 if
 - Levels may exceed the action level (i.e., change category) during maintenance or service



17 Duties of RFSO

- ❑ Initial evaluation & monitor changes
- ❑ Maintain inventory
- ❑ Evaluate existing safety procedures
- ❑ Document program
- ❑ Monitor legal requirements
- ❑ Disseminate RF safety policy to organization
- ❑ Advice to staff on policy & procedures
- ❑ Review/authorize surveys & control measures
- ❑ Maintain list of approved RF personnel
- ❑ Manage medical assessments for potential exposures potential exp > action level



17 Duties of RFSO

- ❑ Coordinate safety awareness training and maintain training records
- ❑ Conduct/arrange site audit (every 3 yrs)
- ❑ Annual review of policy & procedures
- ❑ Manage investigation of breaches of policy & procedures & incidents
- ❑ Develop/approve hazard assessment tools
- ❑ Arrange for regular calibration of measurement equipment
- ❑ Ensure control & archiving of all documentation



Elements of RFSP (Draft)

- Suggested inventory criteria:
 - Device/type, frequency, radiated power, antenna type (if applicable), summary of potential for RF exposure
 - Annex C provides additional guidance on inventory



Exposure Assessment

- ❑ May use existing evaluations or on-site measurements
- ❑ Suggests the use of NCRP Report No. 119
 - ❑ *A Practical Guide to the Determination of Human exposure to Radiofrequency Fields*
- ❑ Annex D – information on measurement
- ❑ Annex E – information on calculations

Control Measures

- ❑ Dependent upon category
- ❑ Summarized in Table similar to ANSI Z136.1
- ❑ Includes:
 - Engineering
 - Administrative
 - PPE
 - Training

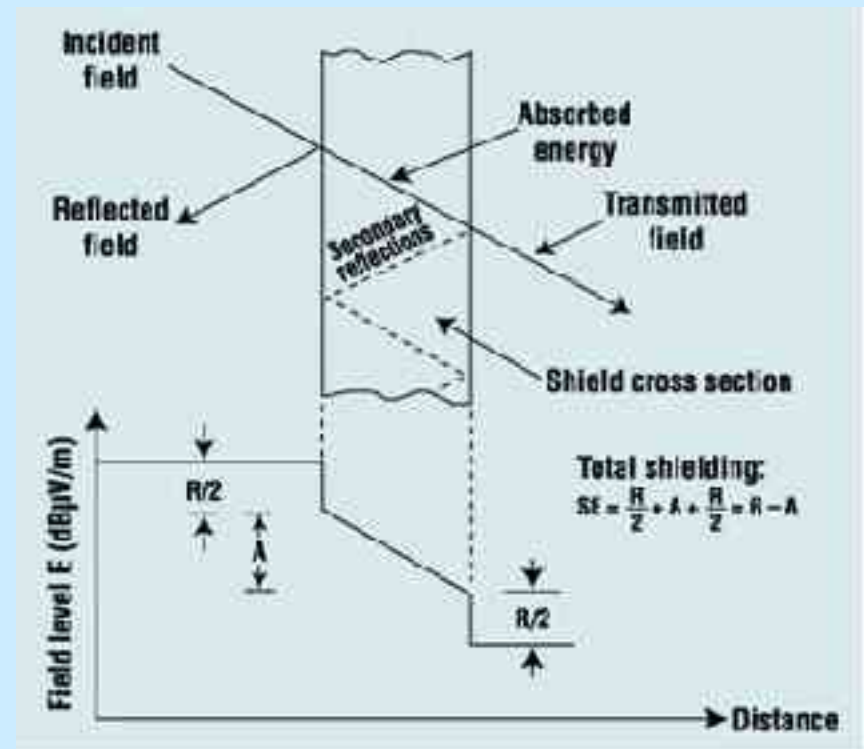
★ Required ✓ Optional — Not applicable

Table 2. Continued.

RPNP Elements	Category 1	Category 2	Category 3	Category 4
4.4 Personal Protective Equipment (PPE)				
4.4.1 Selection of appropriate PPE	—	—	✓	✓
4.4.2 Maintenance and inspection	—	—	✓	✓
4.5 Training				
4.5.1 General RF safety awareness	—	✓	★	★
4.5.2 Explanation of RF exposure limits	—	✓	★	★
4.5.3 RF exposure mitigation controls	—	✓	★	★
4.5.4 Possibility of RF interaction with medical devices & implants considerations	—	✓	★	★
4.5.5 Over-exposure incident response	—	—	★	★
4.5.6 Flammable/explosive device considerations (when present in the work environment)	—	✓	★	★
4.5.7 Sources of additional information	—	—	✓	✓
4.6 Program Audit				
4.6.1 Implementation (Program at use?)	—	★	★	★
4.6.2 Adequacy of present program (program audit)	—	★	★	★
4.7 Assess Ancillary Hazards	—	✓	✓	✓

Engineering Controls

- Configure equipment or site to minimize the potential for exposure
- Use physical barriers to restrict access
- Man-proof barriers & interlocks more effective than administrative controls

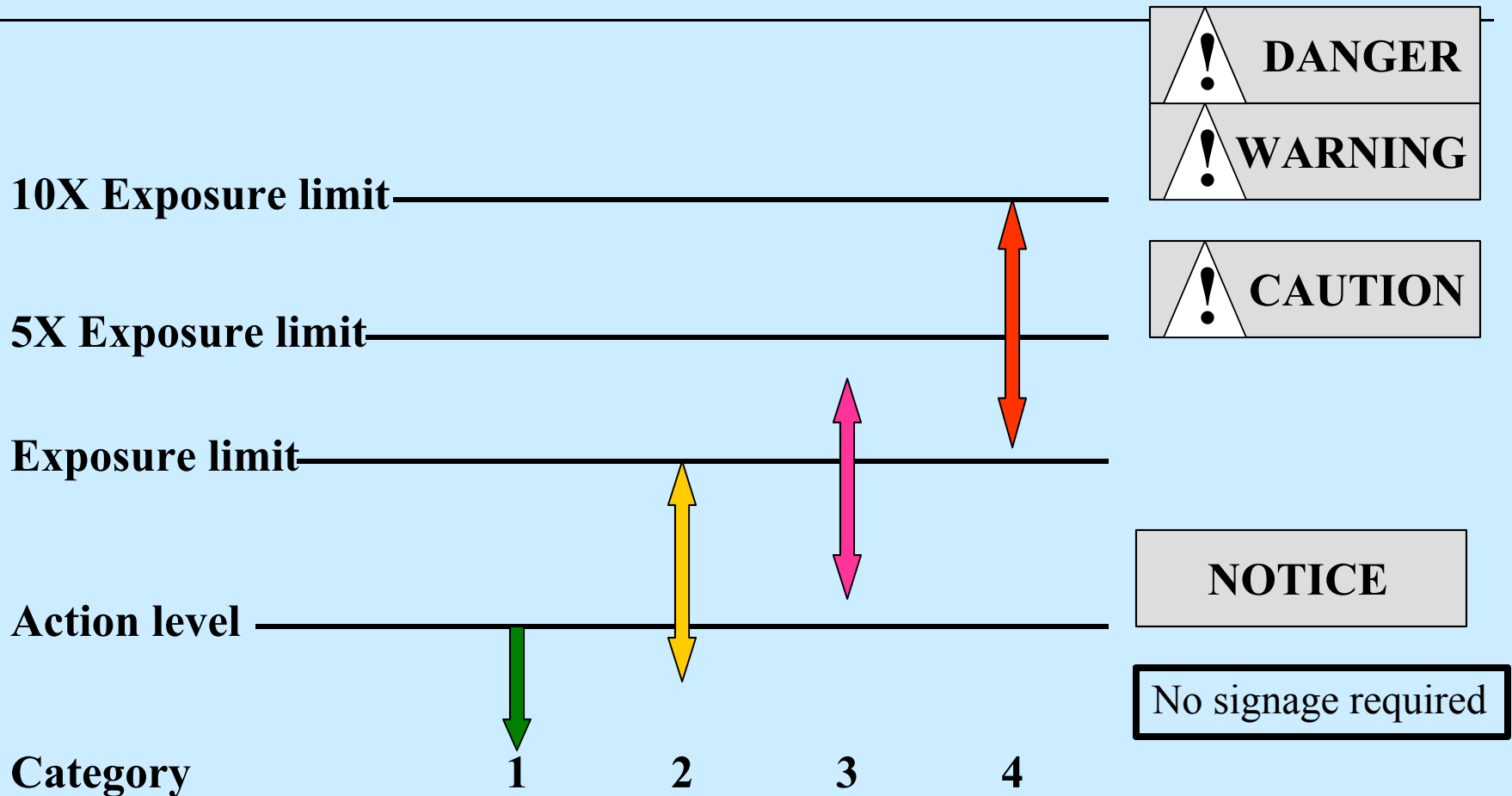


Administrative Controls

- ❑ Signs
- ❑ Work practices
- ❑ Lock-out / tag-out
- ❑ Reduction of operating power
- ❑ Time averaging exposure
- ❑ Use of personal or area monitors



Signage & Signal Words



Personal Protective Equipment



Naptex RF protective clothing

- ❑ Gloves, overalls, socks, shoes, etc.
- ❑ “...care should be used in determining whether RF protective clothing is appropriate in all exposure circumstances.”
- ❑ Train; inspect; maintain



Training

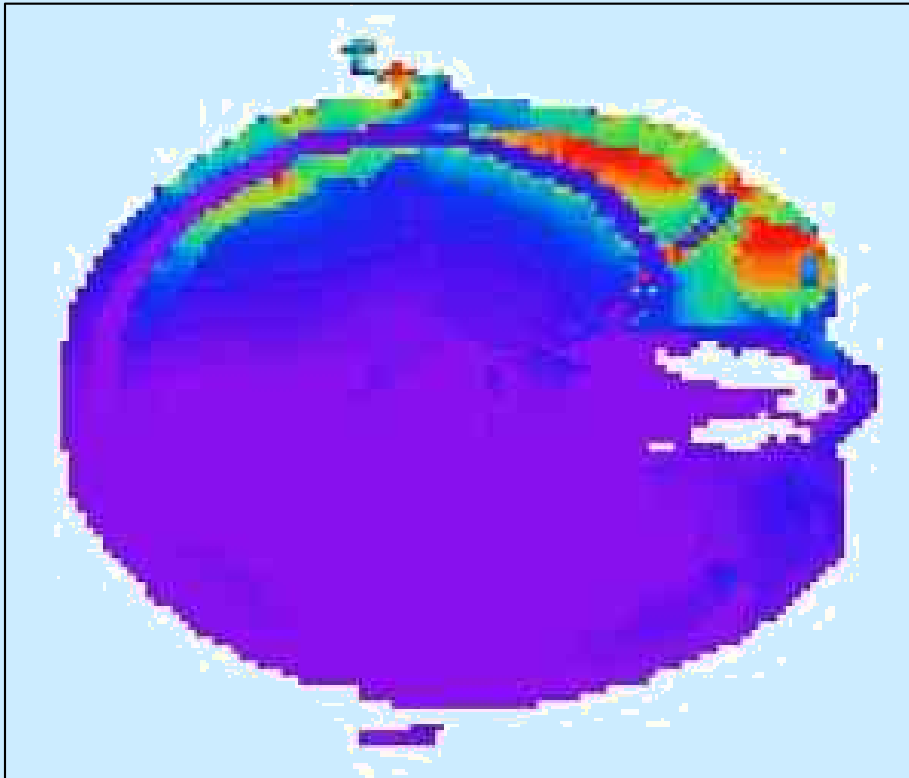
- ❑ “RF safety awareness training is normally the single most important aspect of preventing hazardous exposure to RF energy and is often not sufficiently emphasized in RFSPS.”
- ❑ RF safety awareness training should be provided to all individuals who may access areas where RF exposures may exceed OEL
- ❑ Annex A lists training elements



Training & Information

- ❑ Explanation of RF exposure limits
- ❑ RF exposure mitigation controls
- ❑ Susceptibility of medical devices & implants
- ❑ What to do in case of accidental exposure or RF-related incident
- ❑ Annex A lists training elements

Cell Phones & Brain Cancer



- Exposure to head, ear, eye, hand
- Exposure localized to side of head where phone is used
- SAR decreases with distance into head



Human Studies - Cancer

- 17 reports to date (3 treated as 1)
- Designs: case-control (12); cohort (3); ecological (2)
- End points: all, brain, acoustic neuroma, salivary, ocular melanoma, leukemia



Statistically Significant Associations

- ❑ Laterality & handedness - Swedish studies
- ❑ Analog phone use - Swedish & Finnish studies
- ❑ Tumor type: glioma - Finnish study; acoustic neuroma - Swedish studies
- ❑ None observed consistently



Epidemiology Studies- Limitations

- ❑ Too few studies to be conclusive
- ❑ Issues, but no trends identified
- ❑ Problems with latency period
- ❑ Bias in case-control studies: recall, selection and interview cannot be discounted



Epidemiology Studies - Latency

- ❑ Short follow-up times
- ❑ Slow growing tumors or those with long latency periods might not be captured
- ❑ Long-term, heavy usage not adequately addressed



In Vivo Cancer Studies

- 16 studies: lymphatic, brain, breast, skin, liver
- Designs include
 - Spontaneous tumor development
 - Promotion after dose of known carcinogen
 - Alteration of implanted tumor cells
- One statistically significant outcome (lymphoma), not replicated in study by other researchers



Overall Conclusion

- ❑ Human studies inconclusive
- ❑ Animal studies do not support the hypothesis that wireless exposure is a tumor promoter
- ❑ *In vitro* studies are inconclusive
- ❑ Relative paucity of scientific evidence



Overall Conclusion

- ❑ Weight of available evidence does not support the conclusion that RFR exposure from wireless phones causes cancer.
- ❑ The data are few, the limitations many, and the outcome in the future.

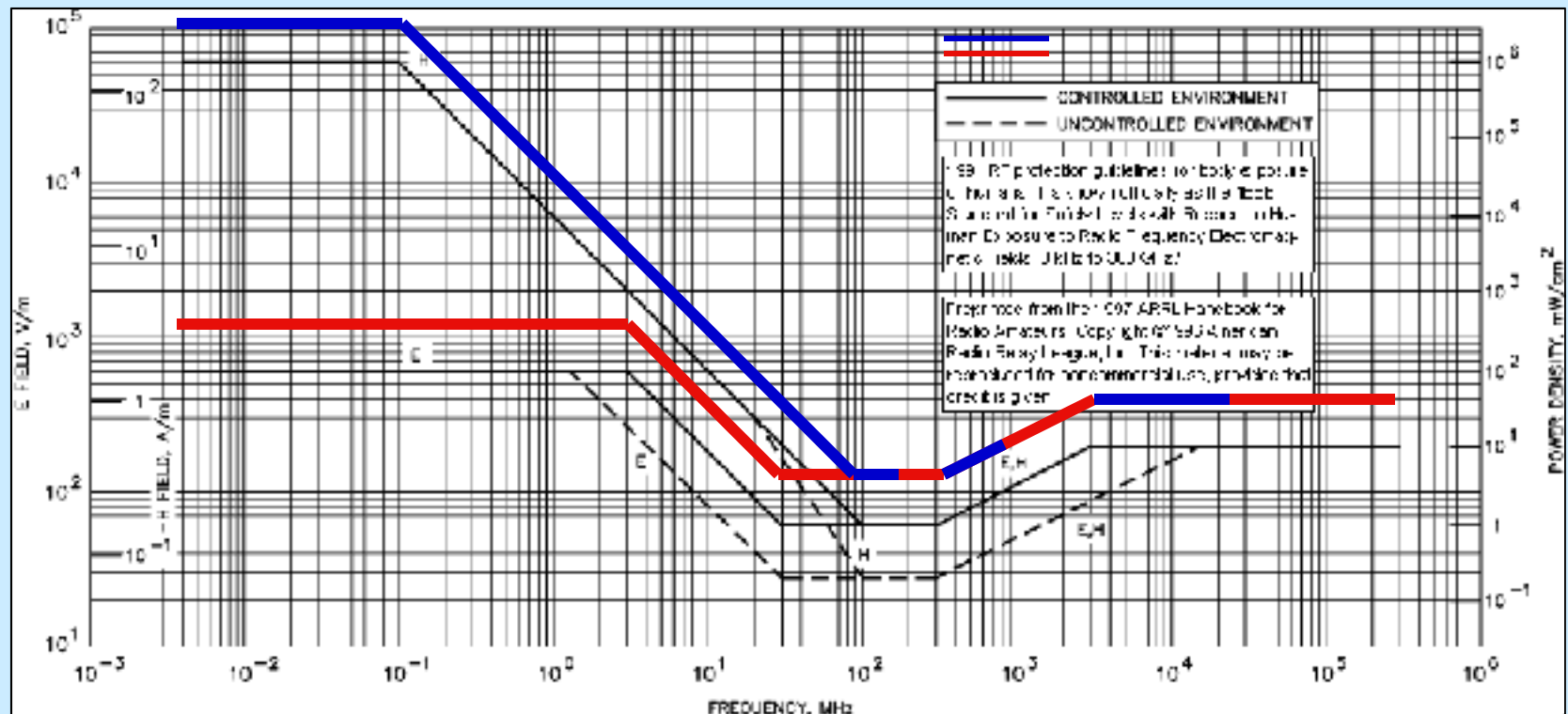


Evaluation of RF Exposure

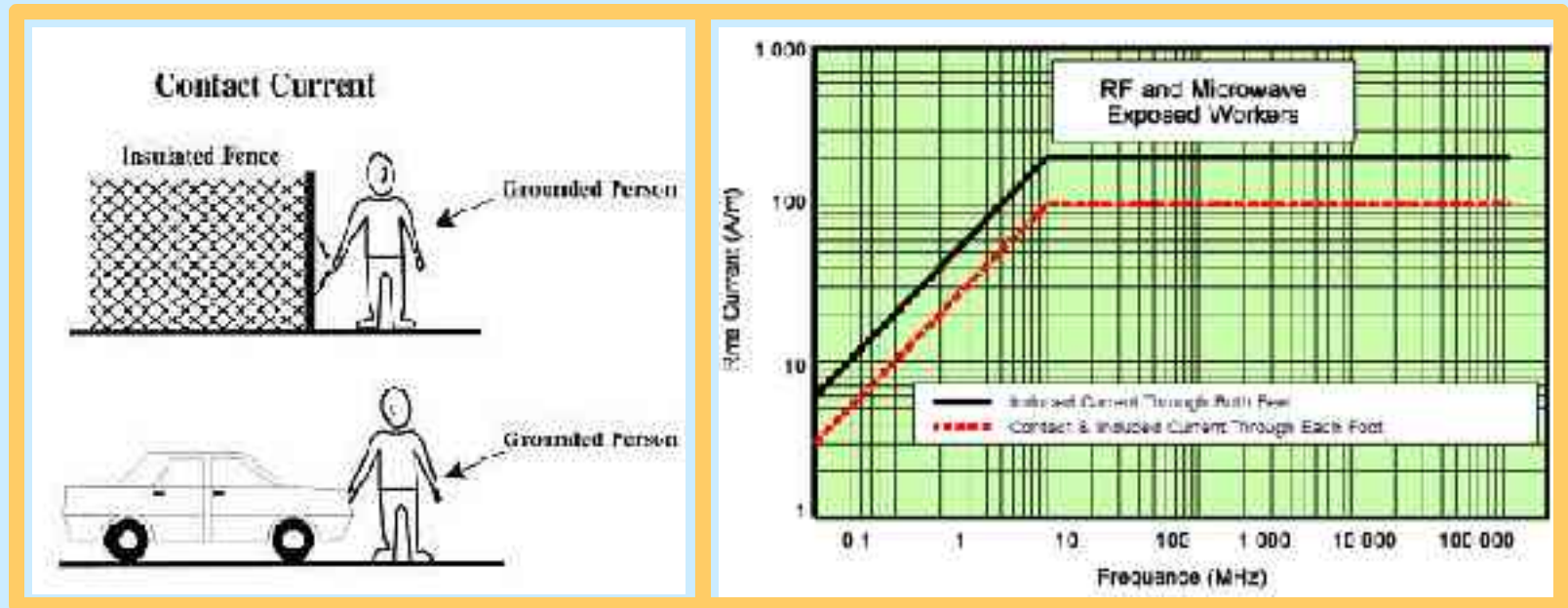
- Intentional radiators (antennas)
 - Numerical modeling
 - Measurement

- Leakage fields
 - Measurement

IEEE Std C95.1, 1999 Edition



Low-Frequency Guidelines



- Low-frequency RF currents may generate heat, burns or shock
- Contact & induced current limits: 3 kHz and 100 MHz

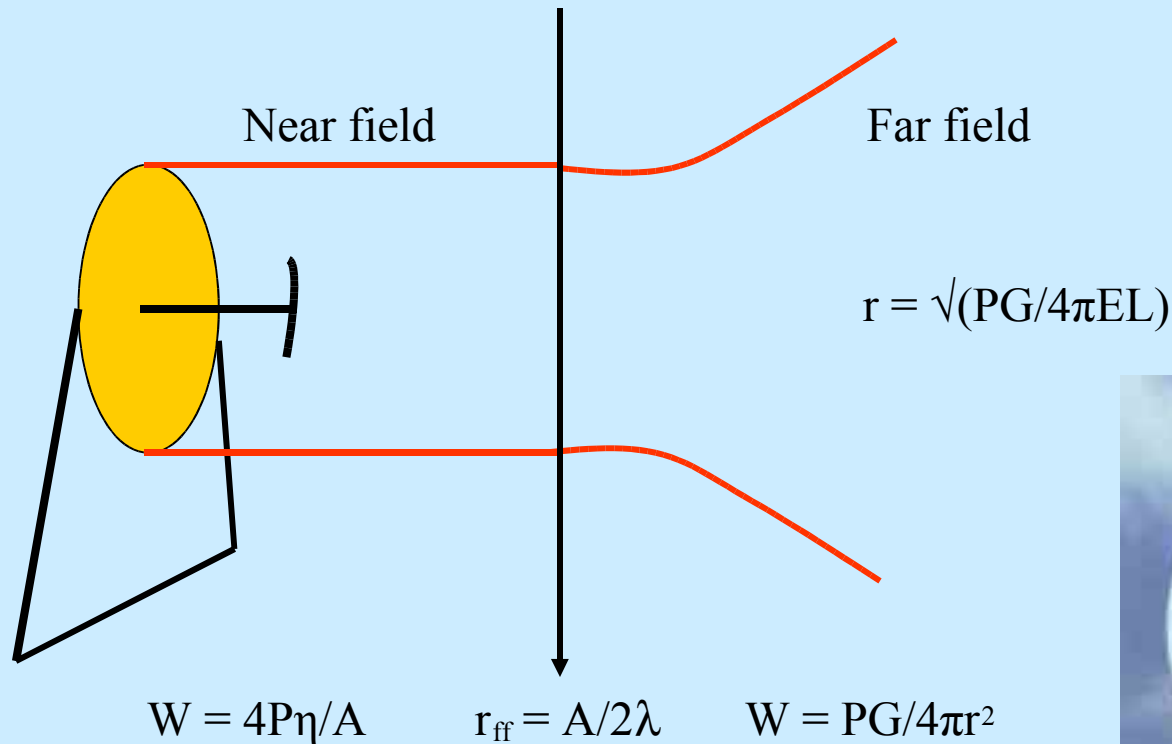


C95.1 Evaluation Requirements

- Measure or calculate field intensity
 - ≥ 300 MHz for leakage source
 - ≥ 100 MHz for intentional radiator

- Measure field strength (E&H)
 - Leakage source
 - ≤ 300 MHz - measure E & H
 - ≤ 100 MHz – measure induced currents
 - ≤ 100 MHz for intentional radiator

Numerical Modeling: Aperture Antennas



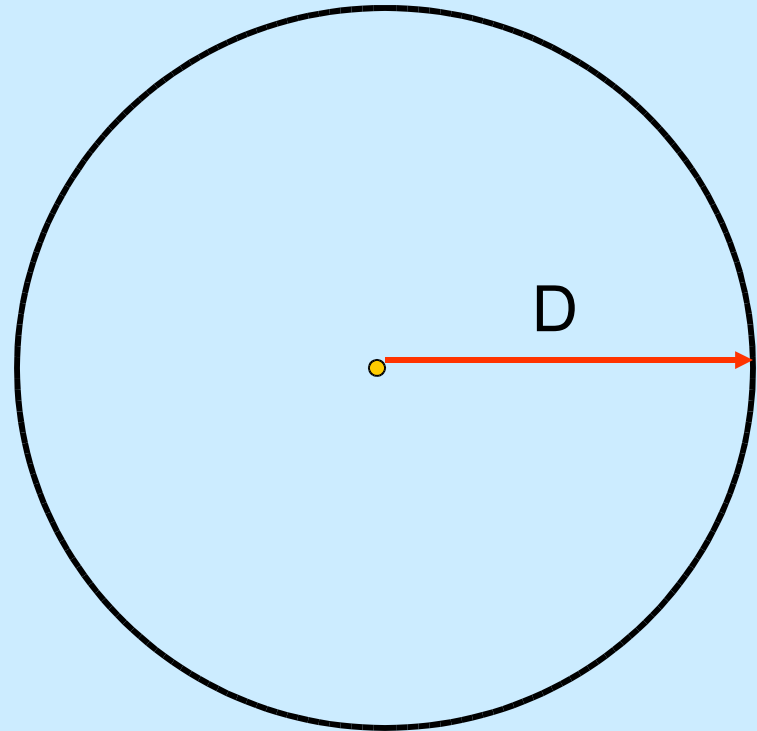
Numerical Modeling

$$S = \frac{PG}{4\pi D^2}$$

S = power density
(W/m² or mW/cm²)

P = power (W or mW)

G = absolute gain



Model applies to a point-source emitter with a spherical radiation pattern.

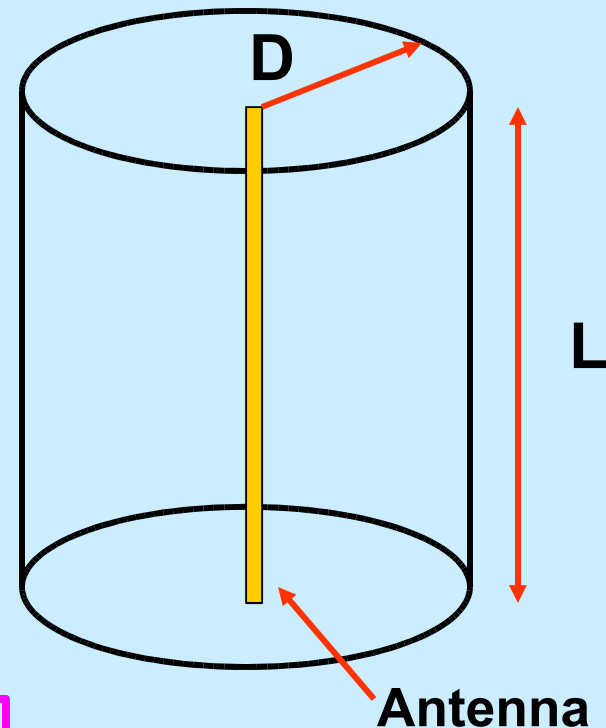
Numerical Modeling

$$S = \frac{P}{2\pi DL}$$

S = power density
(W/m² or mW/cm²)

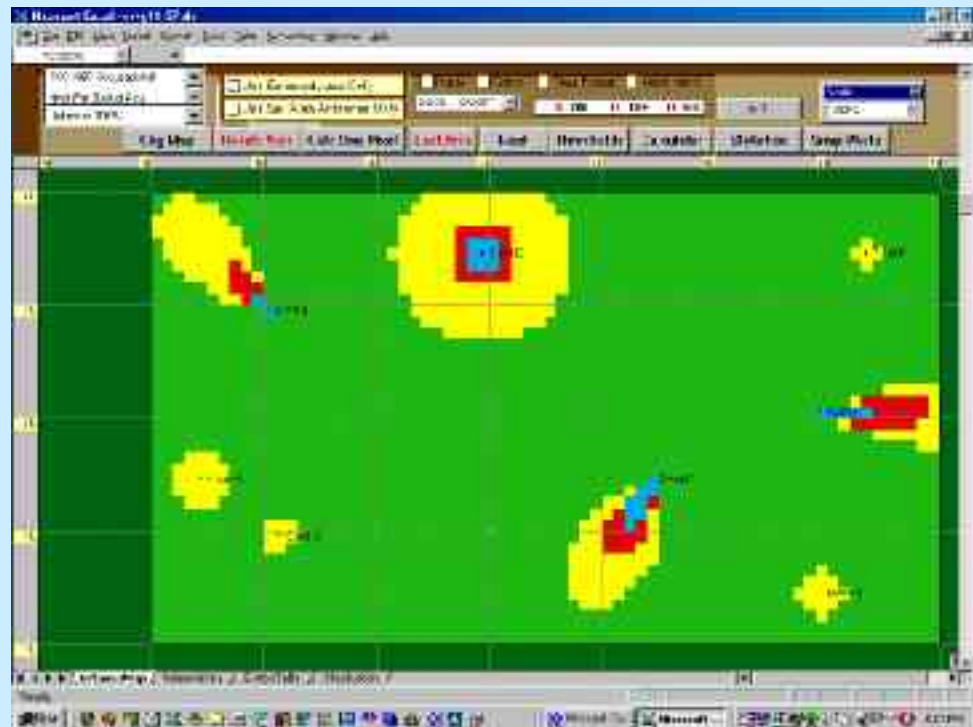
P = power (W or mW)

Model applies to vertical antenna with
horizontal omnidirectional radiation pattern



RoofView® Software

**Useful for multisignal
(multiple emitters)
environments**



Measurement of RF Radiation

- ❑ Requirements depend on frequency
- ❑ Field strength or power density
 - Spatial averaging
 - Time averaging
- ❑ Induced & contact currents
 - Time averaging

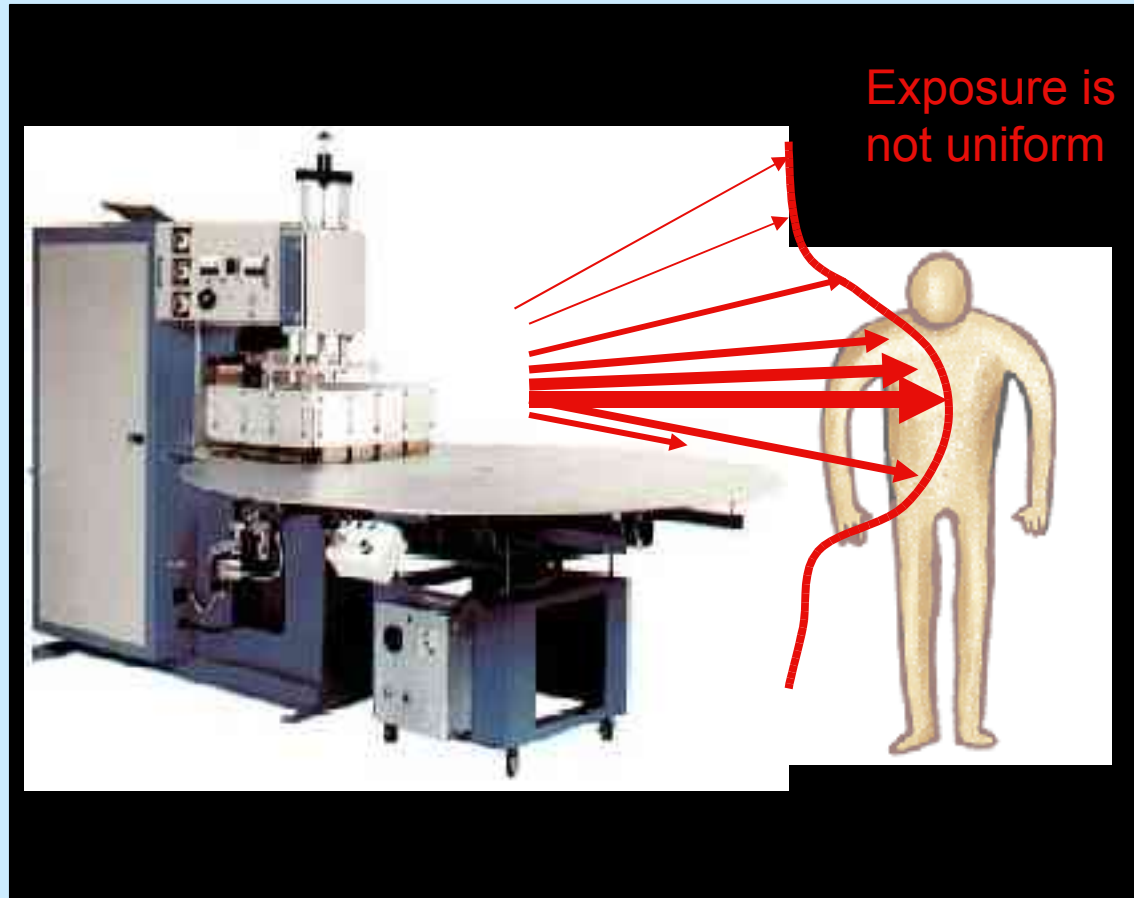




Measurement: General Requirements

- ❑ Determine spatial average exposure and compare to MPE
- ❑ Determine partial-body exposure and compare to frequency-dependent relaxation
- ❑ Determine exposure at location of eyes/testes and compare to MPE

Spatial Averaging



Exposure limit is a WBA, so exposure must be averaged over the whole body, too

Spatial Averaging



- C95.1 allows for linear spatial average over vertical centerline of projected body area
- Use PVC tube “stickman” as guide
- Minimum of 10 readings spaced 20 cm apart between floor and 200 cm

Current Measurement

- ❑ Induced current as foot current (short circuit to ground)
- ❑ Contact current for the grasping hand



ELF Fields

- ❑ Current: 0 to 3000 Hz
- ❑ Classic: 30 to 300 Hz
- ❑ Composed of electric and magnetic fields (not radiation)
- ❑ Primary OELs
 - IEEE C95.6-2002
 - ACGIH sub-RF TLVs



ELF Fields





ELF Fields

- Controversial since 1979 with first report of positive association with cancer
- Currently classified as a Class 2B “possible” human carcinogen by the US NTP
 - Based on childhood leukemia & chronic lymphocytic leukemia in adults
- Exposure guidelines based principally on phosphenes (non-photic ocular response)



ELF Fields – C95.6-2002 Standard

- With revision of C95.1, it will dovetail well with C95.6
- Basic restriction: *in situ* electric field
- Limits for public & controlled environment



ELF Fields – C95.6-2002 Standard

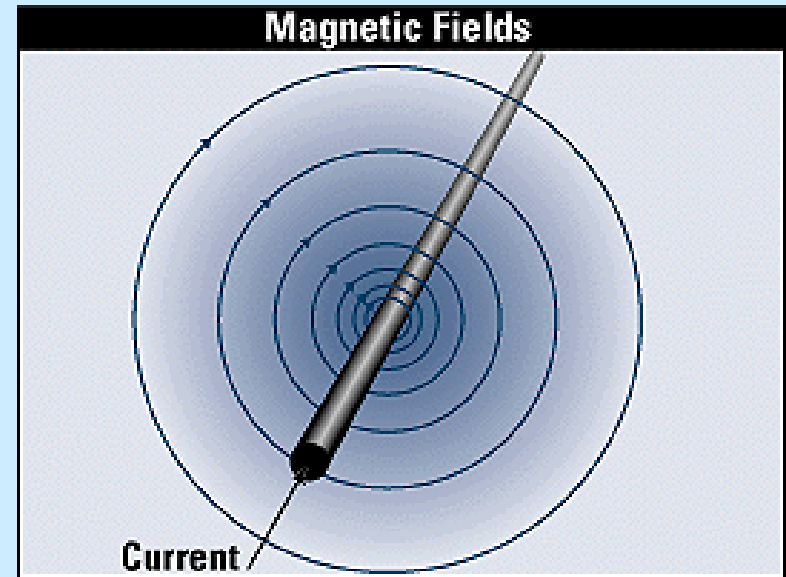
- OEL: MPEs for E and B fields
 - B field: head/torso & arms/legs
 - E field: whole-body exposure
 - In general, limits are higher than sub-RF TLVs


ELF Fields – C95.6-2002 Standard

□ MPEs for induced & contact currents

□ Averaging time

- 0.2 s for $f > 25$ Hz
- 0.2 to 10 s for $f \leq 25$ Hz





ELF Fields – C95.6-2002 Standard

- Biological basis: electrostimulation
 - “depolarization of the excitable cellular membrane (nerve or muscle)”
 - “determined by the electric field in the medium surrounding the excitable tissue ... “

Questions



A REVIEW OF CURRENT US DEPT. OF TRANSPORTATION REGULATIONS FOR PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIALS

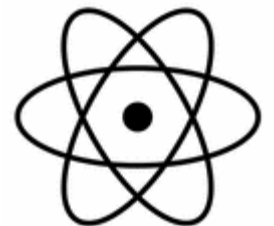


AL GRELLA

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LECTURE 1A

INTRODUCTION AND BACKGROUND

- IAEA REGULATIONS (TS-R-1) ARE BASIS FOR WORLDWIDE NUCLEAR TRANSPORT REGULATIONS
- TS-R-1 IS A MINOR REVISION OF 1996 ST-1
- JAN 26-2004-DOT (HM-230) AND NRC (10CFR71) FINALIZED RULES TO HARMONIZE U.S. REGULATIONS WITH TS-R-1
- BASIC REGULATIONS AFTER THESE AMENDMENTS ARE REVIEWED IN THIS COURSE
- EMPHASIS PLACED ON TYPES OF NASA RAM SHIPMENTS
- ROLES OF DOT AND NRC ARE DESCRIBED
- A1/A2 SYSTEM OF LIMITING RAM PACKAGE ACTIVITY IS DESCRIBED

IAEA TRANSPORT REGULATIONS

- DOT AND NRC PREVIOUSLY ADOPTED REVISIONS BASED ON 1985/1990 VERSION (ISSUED AS ST-1)
- ST-1 WAS RENAMED “TS-R-1” (MINOR REVISIONS)
- DOT & NRC PROPOSED AMENDMENTS TO HARMONIZE WITH TS-R-1 IN APRIL 2002
- DOT & NRC ISSUED FINAL RULES ON JAN 26, 2004
- MANDATORY COMPLIANCE WAS OCT 1, 2004
- FORMER SAFETY SERIES 7 (EXPLANATORY DOC) AND SAFETY SERIES 37 (ADVISORY DOC) HAVE NOW BEEN FOLDED INTO A NEW TS-G-1.1

IAEA SAFETY STANDARDS SERIES

Regulations for the Safe Transport of Radioactive Material

1996 Edition

REQUIREMENTS

No. ST-1



INTERNATIONAL
ATOMIC ENERGY AGENCY
VIENNA

UN/DOT HAZARDOUS MATERIAL CLASSIFICATIONS (49 CFR 173.2)

<u>CLASS</u>	<u>NAME OF CLASS</u>
1	EXPLOSIVES - 6 DIVISIONS
2	GASES-3 DIVISIONS
3	FLAMMABLE & COMBUSTIBLE LIQUIDS
4	FLAMMABLE SOLIDS-4 DIVISIONS
5	OXIDIZERS & ORGANIC PEROXIDES-2 DIVISIONS
6	POISONS & INFECTIOUS MATERIALS-2 DIVISIONS
7	RADIOACTIVE MATERIALS (IAEA STANDARDS)
8	CORROSIVE MATERIALS
9	MISCELLANEOUS HAZARDOUS MATERIALS

THE “NEW” DEFINITION OF “RADIOACTIVE MATERIAL” §173.403

- *RADIOACTIVE MATERIAL* means any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in the table in §173.436 or the values derived according to the instructions in §173.433

Note: previous definition of “radioactive material” was any material in which the activity was essentially uniformly distributed and did not exceed a specific activity of 70 becquerels per gram. No exempt consignment limits stated

Note: NRC states same limit as 173.403, but as “exemption for low level materials”-see §10 CFR 71.14(a)(2)

HAZARDOUS MATERIAL DEFINITION

§49 CFR 171.8

- *“HAZARDOUS MATERIAL means a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety and property when transported in commerce, and has designated as hazardous under section 5103 of Federal hazardous materials transportation law (49USC 5103). The term includes hazardous substances , hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the hazardous Material Table (see 49CFR 172,101), and materials that meet the defining criteria for hazard classes in Part 173 of Subchapter C of this chapter”*

HAZARDOUS SUBSTANCE

49 CFR 171.8

Defined as a material, including its mixtures and solutions that:

- **Is listed in Appendix A to 172.101;**
- **Equals or exceeds the Reportable Quantity (RQ) listed in Table 2 of Appendix A of 172.101;**
- **For radionuclide mixtures , the sum of the fractions rule applies**

HAZARDOUS WASTE DEFINITION

SEE 49 CFR 171.8

- Hazardous Waste is defined as any material that is subject to the hazardous waste manifest requirements of the U.S.Environmental Protection Agency as specified in 40 CFR Part 262
- NOTE: This relates to the Resource Recovery and Conservation Act (RCRA) requirements

CLASSIFICATION OF HAZARDOUS MATERIAL **“PECKING ORDER”**

173.2a

***173.2a Classification of a material having more than one hazard* essentially says that:**

Any hazardous materials not specifically listed in 172.101 that meets the definition of more than one hazard class or division shall be classed according to the highest hazard class in descending order of precedence as listed below:

- 1. Class 7 (RAM, other than a limited quantity)**
- 2. Division 2.3 (poisonous gases)**
- 3. Division 2.1 (Flammable gases)**
- 4. Division 2.2 (nonflammable gases)**
- 5. Division 6.1 (Poisonous liquids, PG-I,PIH only)**
- 6. Division 4.2 (pyrophoric materials)**
- 7. Division 4.1 (self-reactive materials)**
- 8. Class 3 (Flammable liquids), Class 8 (Corrosives), Div. 4.1 (flammable solids), Div. 4.2 (Spont comb), Div. 4.3 (dangerous when wet) Div. 5.1 (oxidizers) or Div.6.1 (other poisons)**
- 9. Combustible liquids**
- 10. Miscellaneous hazardous materials**

REQUIREMENTS FOR MULTIPLE HAZARD LIMITED QUANTITY CLASS 7 (RADIOACTIVE) MATERIALS

§ 173.423 Requirements for multiple hazard limited quantity class 7 (radioactive) materials.

(a) Except as provided in §173.4, when a limited quantity radioactive material meets the definition of another class or division, it must be-

- (1) Classed for the additional hazard
- (2) Packaged to conform with the requirements specified in:
§ 173.421(a)(1) through (a)(5) or 173.424(a) through (g) , as appropriate, and
- (3) Offered for transportation in accordance with the requirements applicable to the hazard for which it is classed

(b) A limited quantity class 7 (radioactive) material which is classed other than Class 7 in accordance with this subchapter is excepted from the requirements of §§ 173.422(a), 172.203(d), and 172.204(c)(4) of this subchapter if the entry “limited quantity radioactive material” appears in the shipping paper in association with the basic description

NUCLEAR TRANSPORT REGULATORY AGENCIES IN THE USA

- * DOT — U.S. Department of Transportation (comparable to “Ministry of Transport” in many countries)**
- * NRC — U.S. Nuclear Regulatory Commission (comparable to “Atomic Energy Agency” or equivalent in many countries)**
- * U.S. Postal Service**
- * DOE — U.S. Department of Energy — controls and regulates shipments of U.S. Government program related nuclear materials**
- * State Agencies — various groups as either radiation, health, energy, environment, or transport regulatory bodies**



OVERLAP EXISTS IN STATUTORY AUTHORITIES OF US REGULATORS

- **TRANSPORTATION IS REGULATED JOINTLY AT THE FEDERAL LEVEL BY DOT AND NRC**
- **DIVISION OF RESPONSIBILITIES BETWEEN DOT AND NRC ARE SPECIFIED IN A MEMORANDUM OF UNDERSTANDING (MOU) (LAST REVISED IN 1979)**
- **PURPOSE OF MOU IS TO AVOID DUPLICATIVE AND CONFLICTING FEDERAL REGULATIONS**

DOT/NRC MEMORANDUM OF UNDERSTANDING

DOT

- **REGULATES SHIPPERS AND CARRIERS**
- **SETS STANDARDS FOR EXCEPTED AND TYPE A PACKAGES AND LSA (Not exceeding 1 r/hr at 3m)**
- **ACTS AS US COMPETENT NATIONAL AUTHORITY WITH RESPECT TO IAEA COMPETENT AUTHORITY CERTIFICATE REQUIREMENTS AND REGULATORY PANELS**

NRC

- SETS STANDARDS FOR AND CERTIFIES TYPE B AND FISSILE PACKAGES
- SETS TRANSPORT SAFEGUARDS STANDARDS
- TECHNICAL ADVISOR TO DOT ON PACKAGING
- ENFORCES DOT REQUIREMENTS ON NRC LICENSEES
- REGULATES LICENSEES' PRIVATE CARRIAGE



71.5

49
10 CFR 71
173

code of federal regulations

Transportation

49

PART 100 TO 185

Revised as of October 1, 1999



49 CFR PARTS 171 TO 178

SUBCHAPTER C-HAZARDOUS MATERIALS REGULATIONS

Titles of Parts

- 171 General information, regulations and definitions
- 172 Hazardous materials table, special provisions ,
hazardous materials communications, emergency
response information, and training Requirements
- 173 Shippers-general requirements for shipment and
packagings
- 174 Carriage by rail
- 175 Carriage by aircraft
- 176 Carriage by vessel
- 177 Carriage by public highway
- 178 Specifications for packagings

49 CFR 173, SUBPART I

FORMAT OF RADIOACTIVE MATERIALS SECTIONS

- 173.401 to 173.403-Scope and Definitions
- 173.411 to 173.419-General and Specific Package Design Requirements and Authorized Packages
- 173.420 to 173.428-UF₆, Excepted package activity limits and requirements, LSA/SCO shipment requirements
- 173.431 to 173.436-Activity limits for Type A and B packages, Determining nuclide values, listing of nuclides on shipping papers and labels and Table of A₁ and A₂ values: Table of Exempt activity Concentrations and Exempt Consignment values
- 173.441 to 173.448- Operational controls, radiation, contamination limits ,storage and general transportation requirements
- 173.453 to 173.459- Fissile materials exceptions, transportation and packaging , mixing of fissile and non-fissile or excepted packages
- 173.461 to 173.469-Test requirements: compliance demonstration Type A and B test requirements ,and LSA-III and special form tests
- 173.471 to 173.476-Administrative requirements for NRC approved, DOT specification packages, foreign packages, and quality control and special form approvals

NRC REGULATION-10 CFR PART 71

PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIAL

SUBPART A-GENERAL PROVISIONS

SUBPART B-EXEMPTIONS

SUBPART C-GENERAL LICENSES

SUBPART D-APPLICATION FOR PACKAGE APPROVAL

SUBPART E-PACKAGE APPROVAL STANDARDS

**SUBPART F-PACKAGE, SPECIAL FORM AND
LSA-III TESTS**

SUBPART G-OPERATING CONTROLS AND PROCEDURES

SUBPART H-QUALITY ASSURANCE

APPENDIX A-DETERMINATION OF A1 AND A2

**NOTE: APPENDIX A IS IDENTICAL TO DOT TABLE OF A1/A2 VALUES
FOUND IN 49 CFR 173.435**

§10 CFR 71.5

TRANSPORTATION OF LICENSED MATERIAL

(a) Each licensee who transports licensed material outside the site of usage, as specified in the NRC license, or where transport is on public highways, or who delivers licensed material to a carrier for transport, shall comply with the applicable requirements of the DOT regulations in 49 CFR Parts 170-189 appropriate to the mode of transport.

(1) The licensee shall particularly note DOT regulations in the following areas:

(I) Packaging—49 CFR Part 173; Subparts A and B and I.

(ii) Marking and Labeling—49 CFR Part 172; Subpart D, §§ 172.400 through 172.407; §§ 172.436 through 172.440, and Subpart E.

(iii) Placarding—49 CFR Part 172 Subpart F; especially §§ 172.500 through 172.519, 172.556, and appendices B and C.

(iv) Accident reporting—49 CFR Part 171, §§ 171.15 and 171.16.

(v) Shipping papers and emergency information—49 CFR Part 172; Subparts C&G

(vi) Hazardous materials employee training—49 CFR Part 172; Subpart H.

(vii) Hazardous material shipper/carrier registration—49 CFR part 107; Subpart G.

(2) The licensee shall also particularly note DOT regulations pertaining to the following modes of transportation:

(I) Rail—49 CFR part 174; Subparts A through D and K.

(ii) Air— 49 CFR Part 175.

(iii) Vessel—49 CFR Part 176; Subparts A through F and M.

(iv) Public highway—49 CFR Part 177 and Parts 390-397.

WHAT MUST I DO
TO MAKE A SAFE AND LEGAL
SHIPMENT OF RADIOACTIVE MATERIALS ?

LSA ?

DOT SPECIAL PERMIT ?

SPECIAL FORM ?

FISSILE MATERIAL ?

SMALL QUANTITY ?

YELLOW III LABEL ?

NORMAL FORM ?

TYPE A PACKAGE ?

TYPE B PACKAGE ?

SECURITY SEAL ?

SPEC. CONTAINER ?

10 CFR 71 ?

LARGE QUANTITY ?

NORMAL FORM ?



49
10 CFR 71
173

code of federal regulations

Transportation

49

PART 100 TO 185

Revised as of October 1, 1989

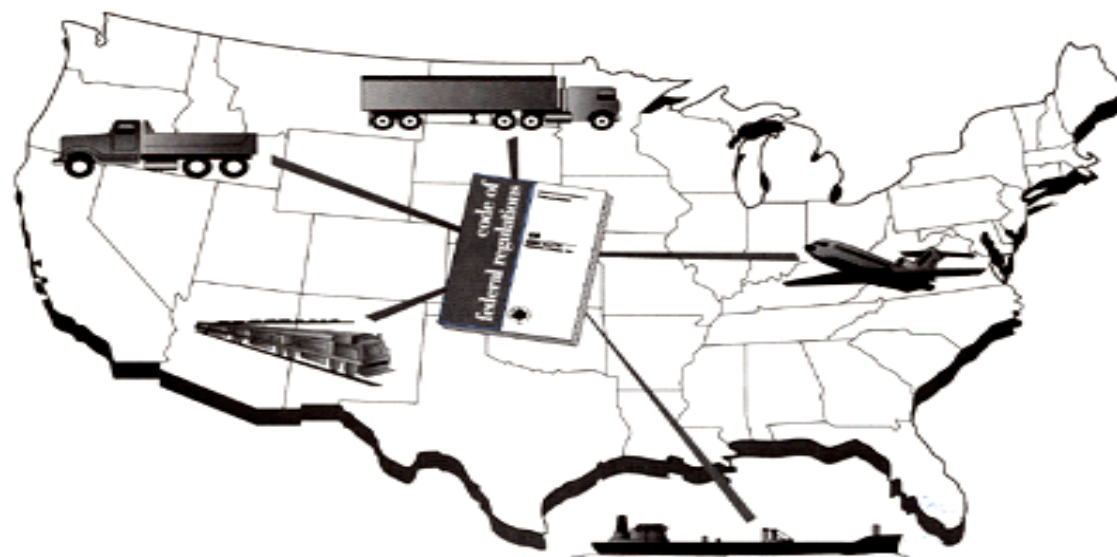




U.S. Department of
Transportation
Research and
Special Programs
Administration

DOT CHART 11

Hazardous Materials Marking, Labeling & Placarding Guide



Refer to 49 CFR, Part 172:

Marking - Subpart D

Labeling - Subpart E

Placarding - Subpart F

Emergency Response - Subpart G

NOTE:

This document is for general guidance only and must not be used to determine compliance with 49 CFR, Parts 100-185.

HOW TO USE

The Hazardous Materials Regulations

CFR 49 Parts 100 To 185

2 0 0 1



U.S. Department of Transportation
Research and Special Programs Administration



U.S. Department of Transportation
Research and Special Programs
Administration

RADIOACTIVE MATERIAL REGULATIONS REVIEW



RAMREG-001-98

LECTURE 1B

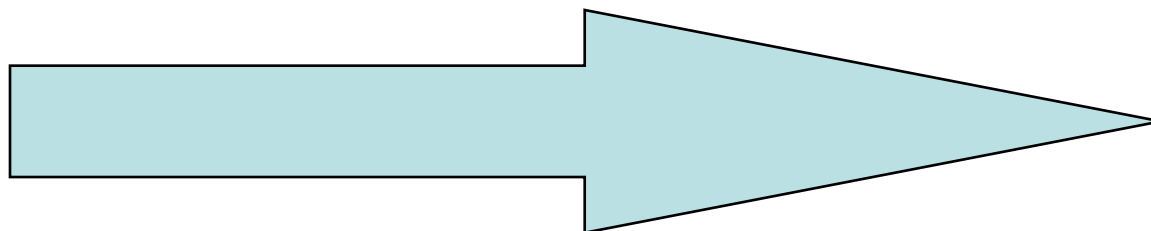
SYSTEM OF LIMITING PACKAGE
ACTIVITY

THE A1/A2 SYSTEM

DETERMINATION OF A-VALUES

USE OF S.I. UNITS

The Transport Package Activity Spectrum



Not Regulated as RAM (Exempt)	Excepted Quantity	Type A Quantity	Type B Quantity
Activity concentrations And total consignment Activity not exceeding §173.436	$10^{-2} A_1/A_2$ inst/articles $10^{-3} A_1/A_2$ limited quantities $10^{-4} A_2$ liquids	A_1 or A_2	$>A_1$ or $>A_2$ Highway Route Control Quantity $>3000 \times A_1$ or $>3000 \times A_2$

THE A_1A_2 SYSTEM

- A_1 means the maximum activity of special form material permitted in a Type A package
- A_2 means the maximum activity of *other than special form material*, LSA material and SCO permitted in a Type A package
- The A_1 and A_2 values are either listed in §173.435, or if not listed, must be derived in accordance with the procedures described in §173.433

NOTE: In the US, Non-special form materials were previously referred to as “normal form” radioactive materials

A₁ A₂ Application Rules

- A₁ and A₂ values are listed in §173.435 for 386 specific radionuclides
- Rules for determining A values for unlisted radionuclides and mixtures are found in §173.433 & Tables 7 & 8 Therein
- Rules for listing of radionuclide mixtures on shipping papers and labels are found in §173.433(g)
- The new §173.436 is a Table of Exempt Material Activity limits and Exempt Consignment Limits, listing about 430 such values for specific radionuclides

NOTE: §§173.433-173.436 are essentially identical to §10 CFR 71, Appendix A , Tables A-1, A-2 , and A-3 therein

A1/A2 VALUES ARE BASED ON COMPARISON OF THE EXPOSURE PATHWAYS LISTED BELOW



Schematic representation of exposure pathways employed in the Q system.

Exposure Pathways Used In A-Value Determinations

- Q_A represents ***external photon dose***
- Q_B represents ***external beta dose***
- Q_C represents ***inhalation dose***
- Q_D represents ***skin dose and ingestion dose by transfer***
- Q_E represents ***cloud submersion dose***

REF: IAEA Document TS-G-1.1

(Advisory Document)

DETERMINING A₁ AND A₂ VALUES **49 CFR 173.433(a)**

For single radionuclides . . .

- **A₁ and A₂ values are determined by the table in 173.435.**

DETERMINING A₁ AND A₂ VALUES **49 CFR 173.433(b)**

For single radionuclides of known identity not found in table . . .

- **A₁ and A₂ values are determined by approval from the Associate Administrator for Hazardous Material Safety**

Except . . .

- **The values for A₁ and A₂ found in Table 10 may be used without approval.**

MIXTURE OF DIFFERENT RADIONUCLIDES

49 CFR 173.433(d)(1)

For special form radionuclides . . .

$$\sum_i \frac{B(i)}{A_1(i)} \leq 1$$

"SPECIAL FORM" RADIOACTIVE MATERIALS

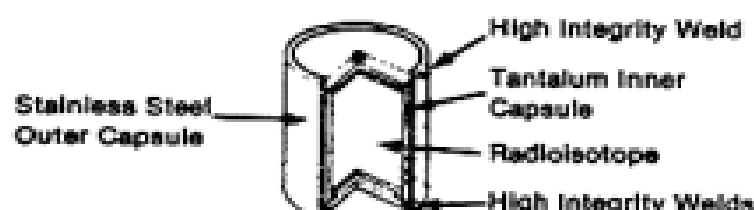
May Present a Direct Radiation Hazard if Released From Package, but Little Hazard Due to Contamination

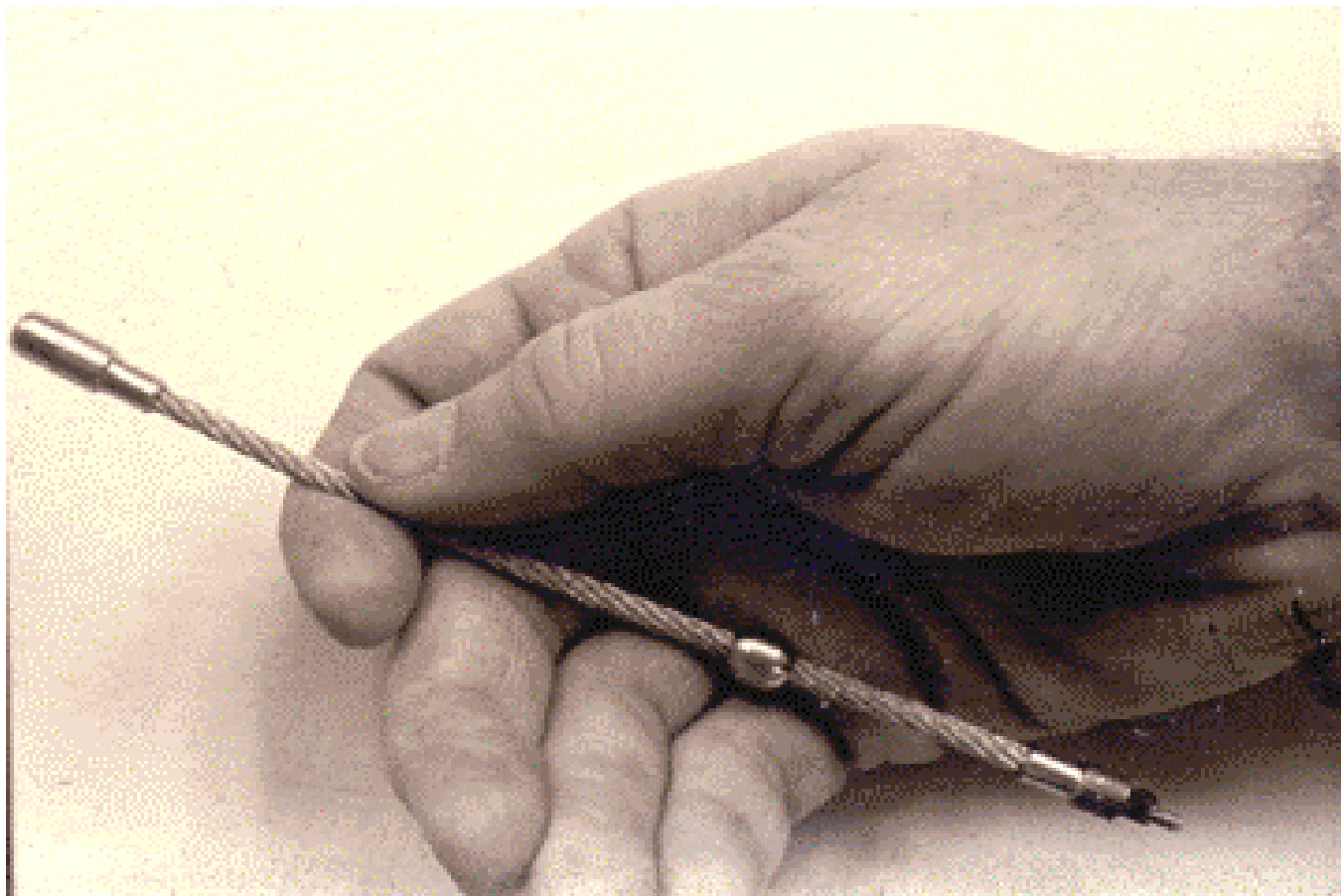
"Special Form" R.A.M. May Be "Natural" Characteristic, I.e., Massive Solid Metal, or "Acquired" Through High Integrity Encapsulation

Massive
Solid Metal



High Integrity
Encapsulation
as a Sealed Source





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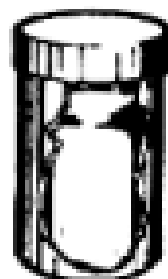
Normal Form Radioactive Materials 49 CFR 173.403

Normal Form Materials May Be Solid, Liquid or Gaseous and Include any Material Which Has Not Been Qualified as Special Form

Type A Package Limits are A_2 Values



Waste Material in
Plastic Bag



Liquid in Bottle Within
Metal Container



Powder in Glass
or
Plastic Bottle



Gas in Cylinder

TYPICAL A₁A₂ VALUES-§173.435

RADIONUCLIDE	ELEMENT & ATOMIC NUMBER	A ₁ LIMIT TBq (Ci)	A ₂ LIMIT TBq (Ci)
C ¹⁴	Carbon (6)	40 (1.1x10 ⁻³)	3.0 (81)
Cs ¹³⁷	Cesium (55)	2.0 (54)	0.6 (16)
Ra ²²⁶	Radium (88)	0.2 (5.4)	0.003 (0.081)
Co ⁶⁰	Cobalt (27)	0.4 (11)	0.4 (11)
Ir ¹⁹²	Iridium (77)	1.0 (27)	0.6 (16)
Nat Thorium	Thorium (90)	unlimited	unlimited
Nat Uranium	Uranium (92)	unlimited	unlimited
Uranium (enriched to 20% or less)	Uranium (92)	Unlimited See 173.434 table	Unlimited See 173.434 table
Mo ⁹⁹	Molybdenum 42)	1.0 (27)	0.6 (16)
Pu ²³⁹	Plutonium (94)	10 (270)	0.001 (0.027)

“Deminimis” or Exemption Levels For Transport of Radioactive Material

- Historically, DOT and IAEA have defined radioactive material for purpose of being subject to transport regulation as material less than 70 Bq/g (0.002 uCi/g) specific activity
- No technical or Scientific Basis Could be Found for the Historic 70 Bq/g value
- ST-1 Eliminates this Definition and Adopts Nuclide-specific Exemption Levels and Consignment Activity Exempt Quantities

- Some exemption Values Change Significantly:

NUCLIDE	exempt Concentration. (Bq/G)	Exempt Activity Per Consignment Bq.
Co-60	10	100,000
Sr-90	100	10,000
Cs-137	10	10,000
Ra-226	10	10,000
U-nat	1	1,000
Pu-239	1	10,000

- Dose basis for deriving numbers was 10 uSv/yr (1 mrem/yr)
- Exemption System will be much more complex

ACTIVITY UNITS

- 1 Curie = 3.7E10 dps
- 1 dps = 1 Becquerel
- 1 Curie = 3.7E10 Bq
- There are 1E12 Bq in one Terabecquerel (TBq)

Thumb Rule: Bq Value $\approx \frac{\text{dpm}}{60}$.

Example: $\frac{2,200 \text{ dpm}}{60} \approx 40 \text{ Bq}$.

Curies

ACTIVITY UNITS

1.0		3.7E10
0.75		2.8E10
0.5		1.85E10
0.25		9.25E9
0.0		0.0

Becquerels

DETERMINATION OF ACTIVITY LIMITS FOR RAM EXCEPTED PACKAGES

Refer to Table 4 of 49 CFR 173.425 which
follows on next slide

§173.425, TABLE 4 -ACTIVITY LIMITS FOR LIMITED QUANTITIES, INSTRUMENTS AND ARTICLES

Nature of Contents	Instruments and Articles		Materials Package Limits ¹
	Limits for each instrument or article ¹	Package Limits ¹	
SOLIDS:			
Special form	$10^{-2} A_1$	A_1	$10^{-3} A_1$
Other forms	$10^{-2} A_2$	A_2	$10^{-3} A_2$
LIQUIDS			
-Tritiated Water:			
<0.0037 TBq/L			37 TBq
0.0037 TBq to 0.037 TBq/L			3.7 TBq
> 0.0037 TBq/L			0.037 TBq
-Other Liquids	$10^{-3} A_2$	$10^{-1} A_2$	$10^{-4} A_2$
Gases:			
Tritium ²	$2 \times 10^{-2} A_2$	$2 \times 10^{-1} A_2$	$2 \times 10^{-2} A_2$
Special form	$10^{-3} A_1$	$10^{-2} A_1$	$10^{-3} A_1$
Other forms	$10^{-3} A_2$	$10^{-2} A_2$	$10^{-3} A_2$

¹ For mixtures of radionuclides see 173.433(b)

² These values also apply to tritium in activated luminous paint and tritium adsorbed on solid carriers

HIGHWAY ROUTE CONTROLLED QUANTITY AS DEFINED IN 173.403

HIGHWAY ROUTE CONTROLLED QUANTITY MEANS A QUANTITY IN A SINGLE PACKAGE WHICH EXCEEDS:

- (1) 3000 x A1 VALUE OF THE RADIONUCLIDES AS SPECIFIED IN 173.435 FOR SPECIAL FORM RADIOACTIVE MATERIAL; OR
- (2) 3000 TIMES A2 VALUE OF THE RADIONUCLIDES AS SPECIFIED IN 173.435 FOR NORMAL FORM RADIOACTIVE MATERIALS; OR
- (3) 1,000TBq (27,000 Curies), WHICHEVER IS LEAST



White square background required for placard for highway route controlled quantity radioactive material.

49CFR 173.501

172.527 AND 172.556



LECTURE 2A

RADIATION AND CONTAMINATION

Definition of ***Transport Index***

Definition of ***Criticality Safety Index***

Definition of ***Contamination***

Radiation Limits On Packages and vehicles

Contamination limits

Shipper Survey Requirements

Receiver Survey Requirements

***Preview of the Radioactive Material
Packaging Spectrum Diagram (Lecture 2B)***

HOW HAS THE “TRANSPORT INDEX” DEFINITION CHANGED ?

The Transport Index (TI) previously was based on either radiation safety **or** nuclear criticality safety. With harmonization to TS-R-1, the TI is **now** based solely on radiation levels .A new “Criticality Safety Index” (CSI) has **now** been defined, replacing the TI when the index is derived solely on nuclear criticality safety. Also, a new FISSILE label has been established in §172.441 for fissile material packages.

TRANSPORT INDEX

- As **now** defined in §173.403 and §10 CFR 71.4:
- Transport Index (TI) means the dimensionless number (rounded up to the next tenth) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The TI is determined by multiplying the maximum radiation level in millisieverts (mSv) per hour at 1 m (3.3 ft) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at 1 m (3.3 ft)).

CRITICALITY SAFETY INDEX

- The new definition ***Criticality Safety Index*** which has now been added to §§173.403 and 71.4, reads:
- “Criticality Safety Index (CSI) means a number (rounded up to the next tenth) which is used to provide control over the accumulation of packages, overpacks or freight containers containing fissile material. The CSI for packages containing fissile material is determined in accordance with the instructions in 10CFR 71.22, 71.23 and 71.59. The CSI for an overpack, freight container, or consignment containing fissile material packages is the arithmetic sum of the criticality safety indices of all the fissile material packages contained within the overpack, freight container or consignment”

EXTERNAL RADIATION UNITS **AND S.I. UNIT CONVERSIONS**

DOSE RATE UNITS

- **1 Sievert = 100 rem**
- **There are 1000 millisieverts (mSv) in one Sievert**

Radiation Level (dose equivalent rate)

1 Sv/h	=100 rem/h= 100,000 mrem/h
1 mSv/h	= 0.1 rem/h = 100 mrem/h
1 uSv/h	= 0.0001 rem/h = 0.1 mrem/h
1 rem/h	= 0.01 Sv/h = 10 mSv/h = 10,000 uSv/h
1 mrem/h	= 0.0000Sv/h= 0.01 mSv/h = 10 uSv/h

RADIATION LEVEL LIMITS

(49 CFR 173.441 or 10 CFR 71.47)

**Limits Set on Packages Shipped Non-exclusive
Use ; or**

**On Packages, Vehicles or Conveyances Carrying
Shipments As Exclusive Use**

RADIATION LIMITS ON PACKAGES AND VEHICLES

(NON-EXCLUSIVE USE SHIPMENTS)

- **PACKAGES (173.441 (a))**
 - **0.1 mSv/h (10 mrem/h)**
 - **0.03 mSv/h (3 mrem/h)-If package intended for shipment on passenger-carrying aircraft**
 - **2.0 mSv/h (200 mrem/h) at package surface**

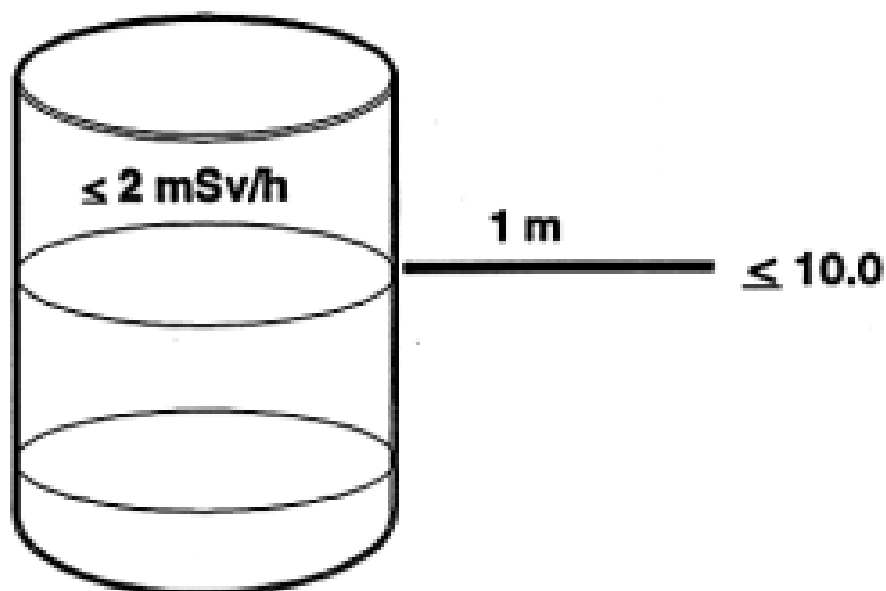
RADIATION LEVELS

Non-Exclusive Use

49 CFR 173.441(a)

* $\leq 2 \text{ mSv/h}$ on contact

* $TI \leq 10.0$



$2 \text{ mSv/h} = 200 \text{ mrem/h}$





TI AND CSI LIMITS DURING TRANSPORT/STORAGE(173.448 AND 173.457)

- For passenger aircraft, no single package or overpack may exceed TI of 3
- For cargo-only aircraft, overpack TI sum may not >10
- For non-exclusive use shipments of fissile, CSI not >50
- For exclusive use shipments of fissile, CSI total in Freight container or conveyance may not be > 100
- Fissile and non-fissile CSI and TI limits on vessels found in §§176.700-176.720
- Sum of CSI's for fissile groups in a storage area not > 50
- Groups of fissile packages stored to maintain spacing not <6m (20 ft) between surfaces of any 2 groups



MODAL-SPECIFIC TRANSPORT AND STORAGE TI AND CSI LIMITS

- Rail shipments-§§174.700 to 174.715
- Aircraft shipments-§§175.700 to 175.705
- Vessel Shipments-§§176.700 to 176.715
- Highway Shipments-§§177.842 & 177.843

STOWAGE DISTANCE TABLES OF TRANSPORT MODES ARE NOT IDENTICAL

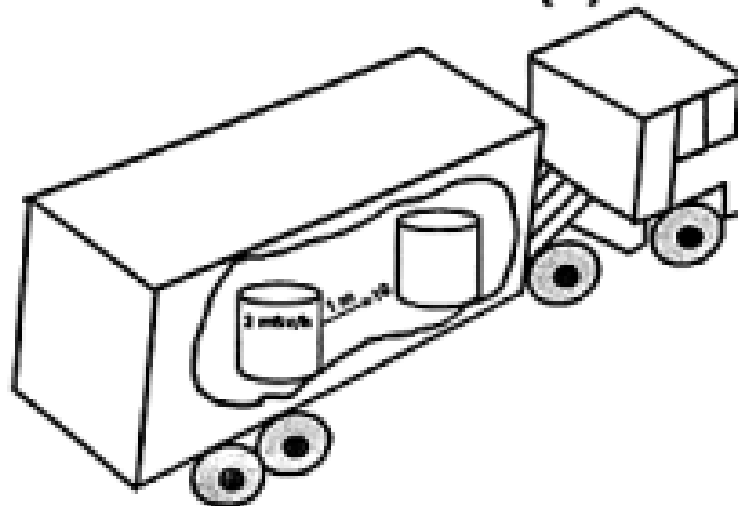
- Highway (§177.842) and Rail (§174.700) stowage tables of distance are essentially identical
- Air Transport Tables (§§175.701 and 175.702) differ and require larger distance separations and allow stowage of more than one group of packages in pre-designated areas when plan is approved by DOT
- Vessel segregation tables (§§176.704 and 176.708) also differ, but allow up to 200 TI total on vessel under certain specified limitations
- All of the modal segregation tables also have separate limits for distance separation from undeveloped film based on duration of transport
- Air Transport Table interestingly requires certain separation from live animals in cargo-only aircraft , based on duration of flight [§175.702(b)(2)(B)]

STOWAGE DISTANCES FOR PACKAGES
BASED ON TRANSPORT INDICES
Highway Carriage-§177.842

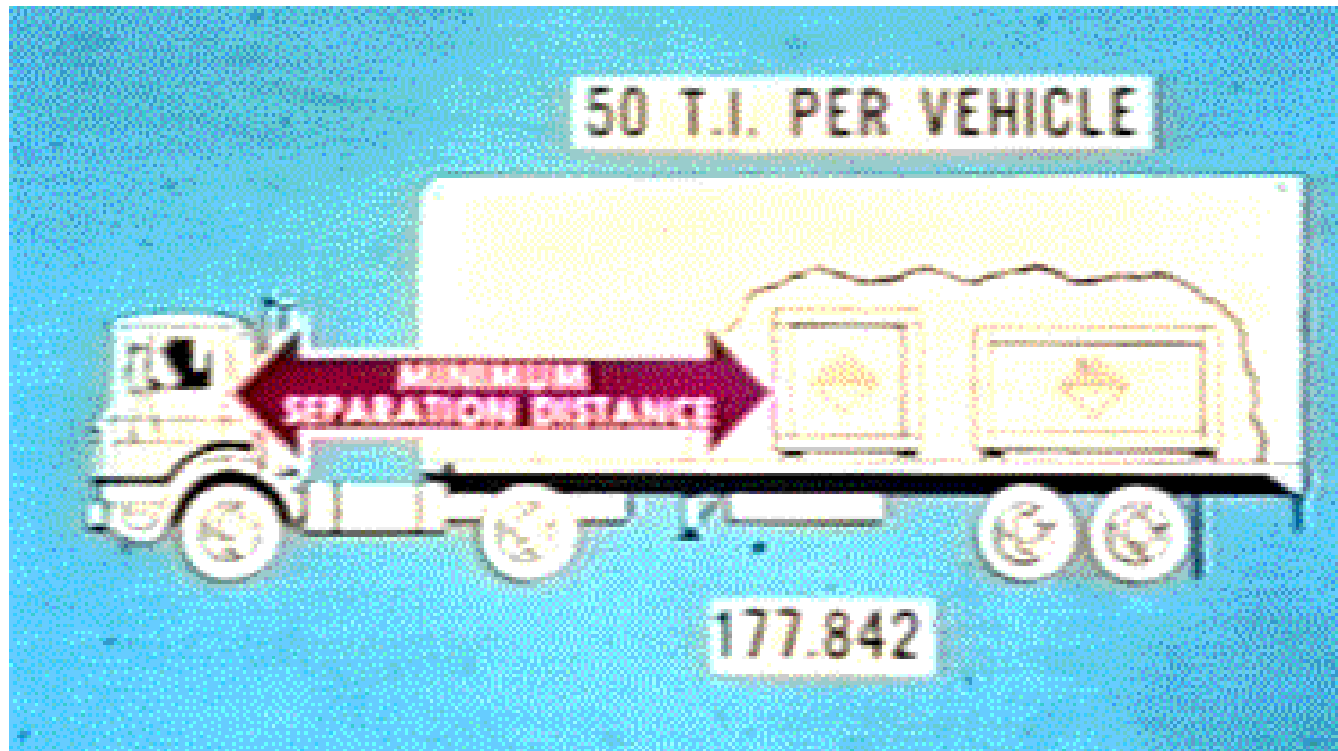
Total Transport Index	Minimum Separation distance in meters (ft) from areas with occupied by persons or from dividing partitions of cargo compartments
None	0
0.1 to 1.0	0.3 (1)
1.1 to 5.0	0.6 (2)
5.1 to 10.0	0.9 (3)
10.1 to 20.0	1.2 (4)
20.1 to 30.0	1.5 (5)
30.1 to 40.0	1.8 (6)
40.1 to 50.0	2.1 (7)

NON-EXCLUSIVE USE OPEN OR CLOSED TRANSPORT

49 CFR 173.441(a)



- 2 mSv/h (200 mrem/h) at any point on the external surface of the package
- $TI \leq 10$
- Total TI is not to exceed 50 per 49 CFR 177.842(a)
- Stowage of packages within the vehicle must comply with 49 CFR 177.842(b)





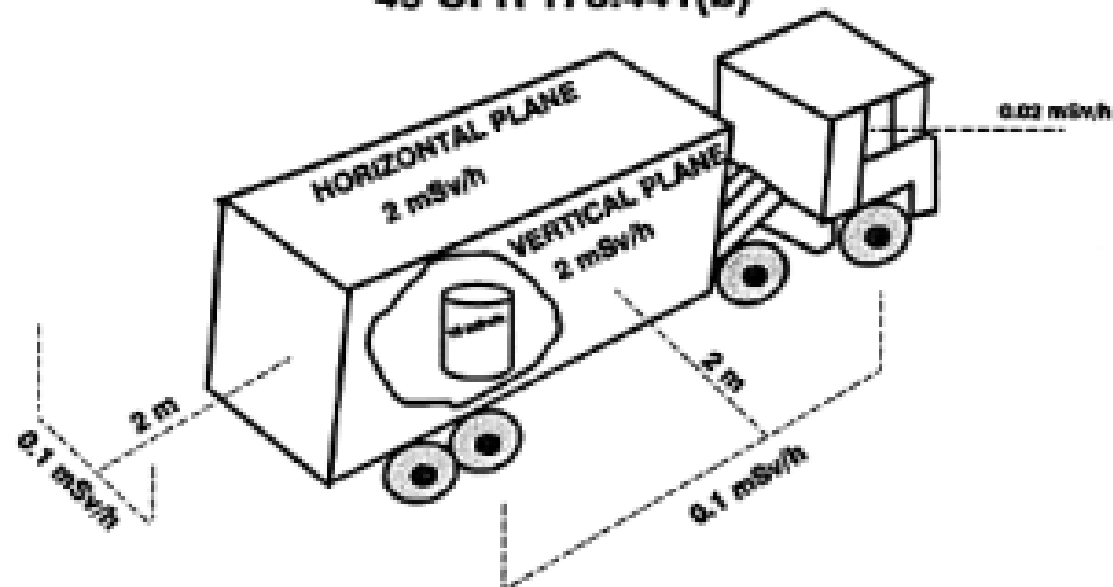
EXCLUSIVE USE RADIATION LEVELS

49 CFR 173.441(b)

APPLICABILITY PACKAGE	CLOSED VEHICLE	OPEN VEHICLE
	≤ 10 mSv/h	≤ 2 mSv/h
VEHICLE	≤ 2 mSv/h top, bottom, sides ≤ 0.1 mSv/h 2 meters from sides ≤ 0.02 mSv/h in cab	≤ 2 mSv/h at vertical planes, under vehicle, top of load ≤ 0.1 mSv/h 2 meters from vertical planes ≤ 0.02 mSv/h in cab

EXCLUSIVE USE CLOSED TRANSPORT

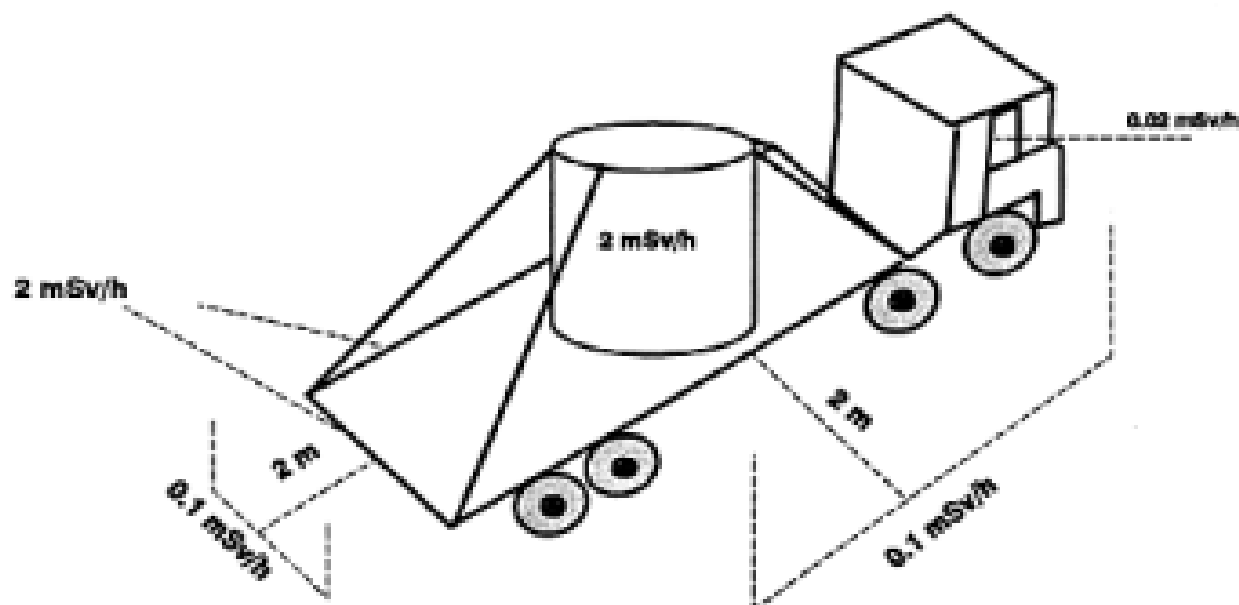
49 CFR 173.441(b)



- * 10 mSv/h at any point on the external surface of the package;
- * 2 mSv/h at any point on contact with the outside of the trailer;
- * 0.1 mSv/h at any point 2 meters from the vertical planes projected by the outer lateral surface of the vehicle;
- * 0.02 mSv/h in cab.

EXCLUSIVE USE OPEN TRANSPORT

49 CFR 173.441(b)



- 2 mSv/h on the external surface of the package
- 2 mSv/h at the vertical planes of the vehicle
- 0.1 mSv/h at any point 2 meters from the vertical planes projected from the outer edges of the vehicle
- 0.02 mSv/h in the cab



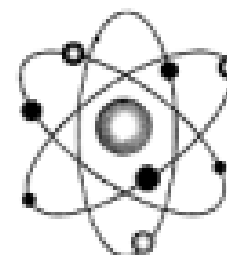
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CONTAMINATION LIMITS

§ 173.443 or § 71.87(i)

RADIOACTIVE CONTAMINATION



presence of a radioactive substance on a surface
in quantities in excess of :

- 0.4 Bq/cm² for beta/gamma-emitters and
low toxicity alpha-emitters
- 0.04 Bq/cm² for all other alpha-emitters

“CONTAMINATION” IS NOW DEFINED in §173.403

- **CONTAMINATION** means the presence of a radioactive substance on a surface in quantities in excess of 0.4 Bq/cm² for beta and gamma emitters and low toxicity alpha emitters or 0.4 Bq/cm² for all other alpha emitters
- Contamination exists in two phases.
- (1) **Fixed radioactive contamination** means radioactive contamination that cannot be removed from a surface during normal conditions of transport.
- (2) **Non-fixed radioactive contamination** means radioactive contamination that can be removed from a surface during normal conditions of transport

***THE ADDITION OF A DEFINITION OF
“CONTAMINATION” IS VERY SIGNIFICANT***

DOT stated in its preamble to the HM-230 final rule in Jan 2004 that the quantitative definition of contamination in its previous HM-169A harmonization rulemaking in Sept 1995 ...”was inadvertently omitted.” As a result of the addition of this definition, now non-radioactive materials with radioactive substances on the surface with levels below those in the definition of contamination need not be considered radioactive ***for purposes of transportation*** . In other words, this is actually an ***exemption from regulation***

49
10

CONTAMINATION CONTROL

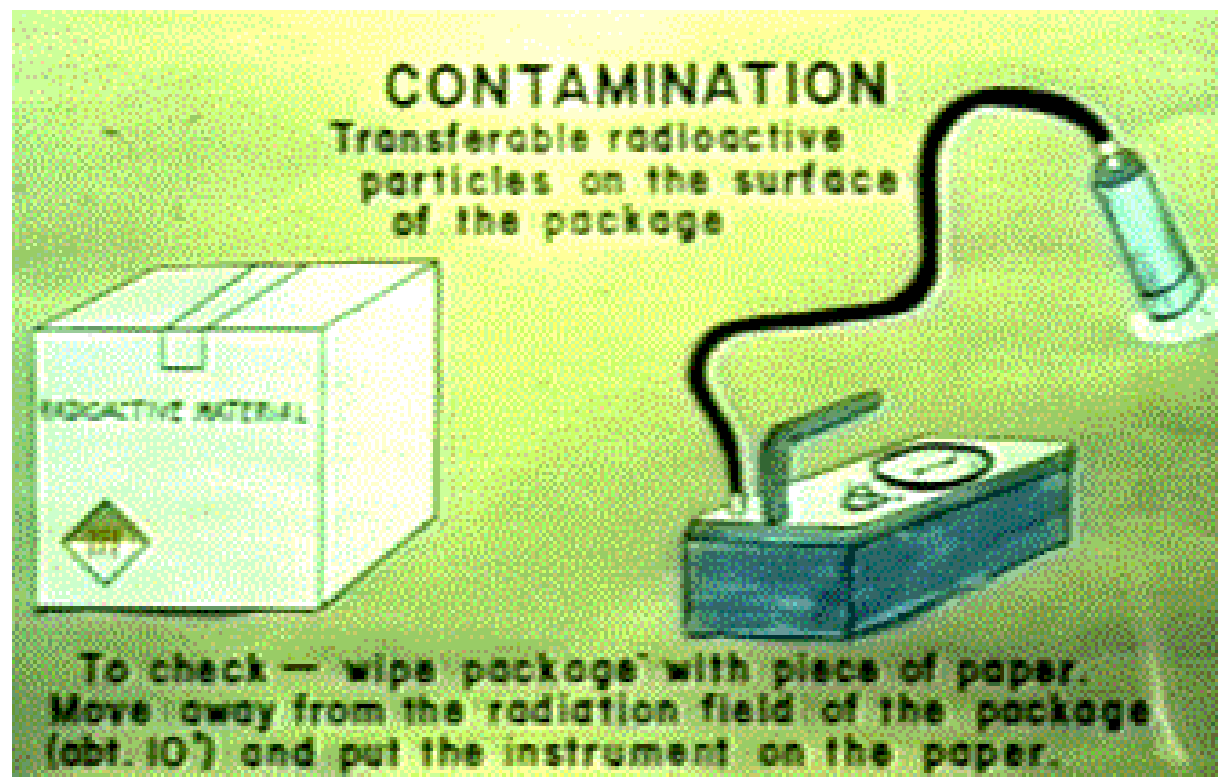
§173.443 TABLE 9

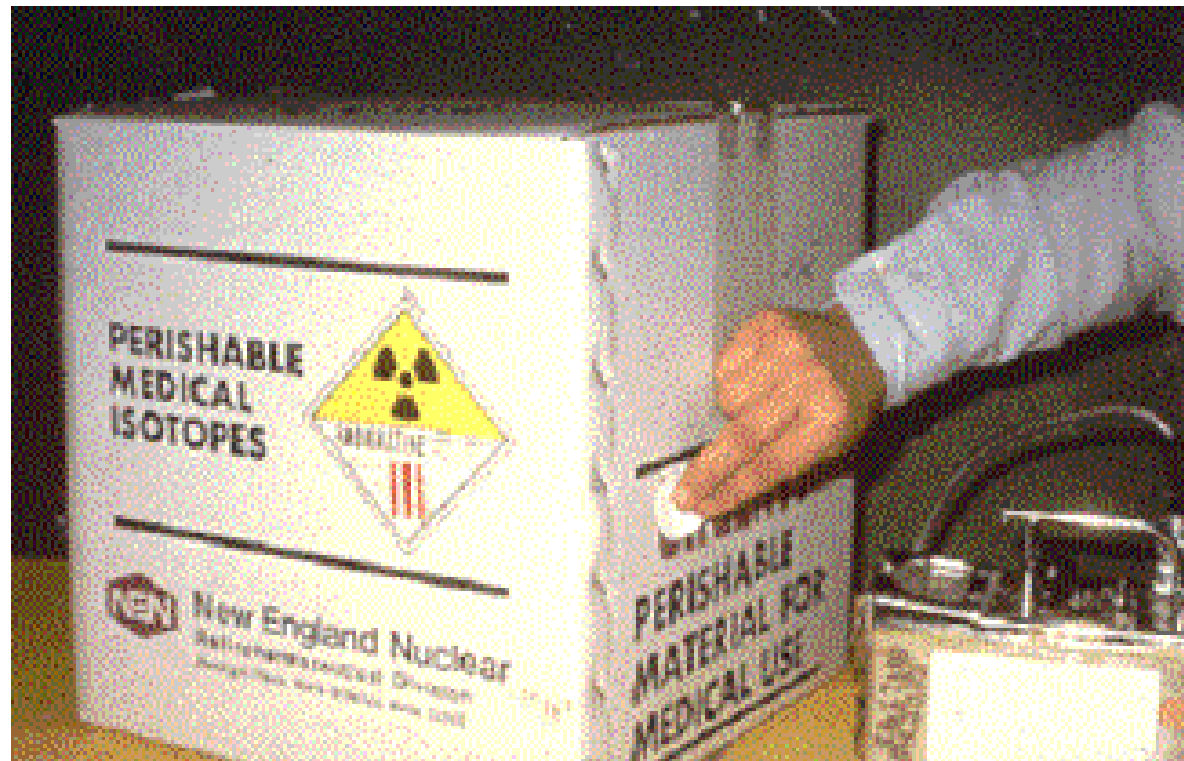
NON-FIXED EXTERNAL RADIOACTIVE CONTAMINATION LIMITS FOR PACKAGES

Contaminant	limit Bq/cm ²	limit uCi/cm ²	Limit dpm/cm ²
1. Beta & gamma emitters and low toxicity alpha emitters	4	10 ⁻⁴	220
2. All other alpha emitting nuclides	0.4	10 ⁻⁵	22

CLARIFICATION OF TABLE OF CONTAMINATION LIMITS

Prior to the final rules for harmonization (HM-230), The stated d/m/cm² limits of Table 11 at §173.441 were 1/10 of the limits stated in IAEA regulations (TS-R-1) and were applicable to the wipe sample itself. The US regulations have stated the IAEA limits thusly since 1973, assuming 10% efficiency for the wipe itself. With HM-230, Table 11 has been renumbered to Table 9. The preamble then states that Table 11 has been revised to reflect the true non-fixed contamination limits for outer package surfaces. §173.443(a)(1) has also been revised to indicate that in calculating the contamination levels from the activity measured on the wipe sample, the true wipe efficiency must be used or a default efficiency of 0.10 may be assumed.





PACKAGE SURFACE CONTAMINATION LIMITS-Table 9, 173.443

1. NON-EXCLUSIVE USE

< 220 dpm/100 cm² beta, gamma, low toxicity alpha
<22 dpm/100cm² all other alpha

2. EXCLUSIVE USE

Start of Transport	< Table 9
During Transport and On Receipt	<10 x Table 9

3. Dedicated Exclusive Use	< 10 X Table 9
return to non-dedicated ex. Use	< Table 9

DOT REQUIREMENTS TO SURVEY PACKAGES FOR EXTERNAL RADIATION AND CONTAMINATION

Found in 49 CFR 173.475 (i):

**“173.475 Quality control requirements prior to
each shipment of radioactive materials**

**Before each shipment of any radioactive materials package, the
shipper shall ensure by examination or appropriate tests that:**

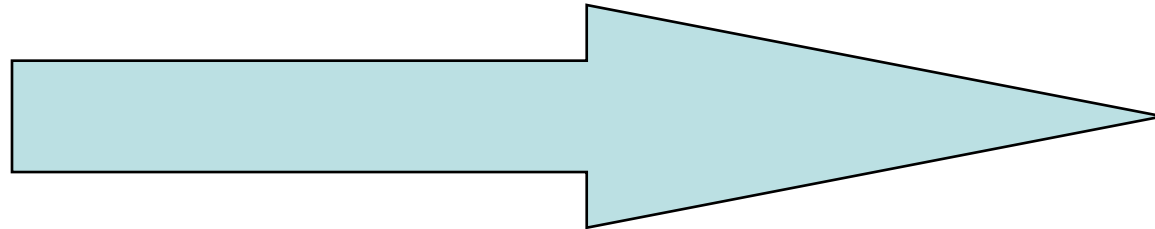
**(i) External radiation and contamination levels are within the
allowable limits specified in this subchapter”**

NRC REQUIREMENT FOR RECEIVERS OF RADIOACTIVE PACKAGES TO SURVEY FOR RADIATION LEVELS AND CONTAMINATION UPON RECEIPT

SUMMARY OF 10CFR 20.1906 PROVISIONS

- Except for packages containing gaseous or special form RAM, any package bearing either of the three RADIOACTIVE labels must be monitored for external surface contamination
- Monitoring of the external radiation level is required for any package bearing GREATER THAN a Type A quantity of radioactive material
- Monitoring for BOTH surface contamination AND external radiation levels must be performed on ANY package known to contain radioactive material. If there is evidence of degradation of package activity
- Instances of surface contamination and/or external radiation levels which are observed in excess of the applicable regulatory limits must be reported to the appropriate NRC regional office.

The Transport Package Activity Spectrum



Not Regulated as RAM (Exempt)	Excepted Quantity	Type A Quantity	<u>Type B</u> <u>Quantity</u>
Activity concentrations And total consignment Activity not exceeding §173.436	$10^{-2} A_1/A_2$ inst/articles $10^{-3} A_1/A_2$ limited quantities $10^{-4} A_2$ liquids	A_1 or A_2	$>A_1$ or $>A_2$ Highway Route Control Quantity $>3000 \times A_1$ or $>3000 \times A_2$

LECTURE 2B

The Transport Package Activity

Fundamental Premises of RAM Packaging Safety

“Packaging” vs. “Package” Concepts

Limits Based on Package Activity

Limits Based on Specific Activity

**SAFETY IN TRANSPORT
OF
RADIOACTIVE MATERIALS
IS
BASED PRINCIPALLY
ON THE USE OF
PROPER PACKAGING**

THE PURPOSE OF THE NUCLEAR TRANSPORT REGULATIONS IS TO ACHIEVE SAFETY BY:

- **Effective containment of the material;**
- **Effective control of the radiation emitted from the package;**
- **Preventing "criticality for fissile radioactive material;**
- **Adequate dissipation of any heat generated within the package.**

“PACKAGING” vs. “PACKAGE”

As Defined In 49 CFR 173.403:

“Package” means , for Class 7 (radioactive) materials , the packaging, together with its radioactive contents as presented for transport .

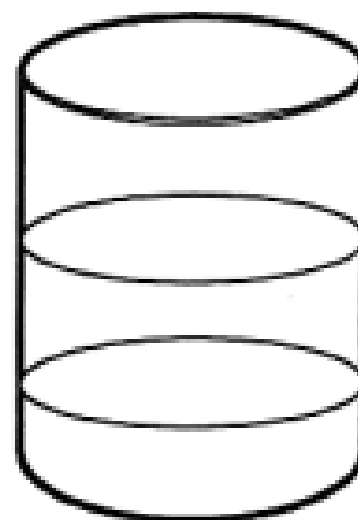
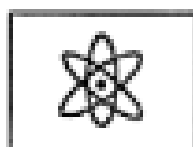
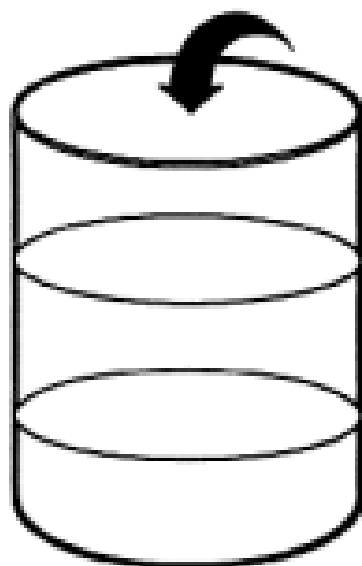
Whereas:

“Packaging” means , for Class 7 (radioactive) materials, the assembly of components necessary to ensure compliance with the packaging requirements of this subpart. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, service equipment for filling, emptying, venting and pressure relief, and devices for cooling or absorbing mechanical shocks. The conveyance, tie-Down system, and auxiliary equipment may sometimes be designated as part of the packaging”

Packaging vs Package

Packaging

- * Containment System
- * Manufacturing Specifications
- * 49 CFR 178



Package

- * Material and Container
- * Meet Performance Criteria
- * Type A - 49 CFR 173.465
- * Type B - 10 CFR 71.71 and 71.77
- * IP-1, 2, 3 - 49 CFR 173.411

RADIOACTIVE MATERIAL PACKAGE CATEGORIES

BASED ON ACTIVITY OR SPECIFIC ACTIVITY

BASED ON ACTIVITY:

- ⋮ Excepted Quantities In Excepted Packaging
 - Limited quantities (173.421, 173.422, 173.423, 173.425)
 - Excepted Instruments or Devices (173.424, 173.425)
 - Excepted Mfd Articles With U, DU, or Th (173.426)
 - Empty Packaging With Residual Radioactivity (173.428)
- Type A Quantity In Type A Packaging (173.412, 173.415)
- Type B Quantity In Type B Packaging (173.416)
 - Includes Highway Route Control Quantity , HRCQ (173.403)

- **BASED ON SPECIFIC ACTIVITY:**
 - Low Specific Activity (LSA) ,173.427
 - LSA-I, LSA-II, LSA-III
 - Surface Contaminated Objects (SCO), 173.427
 - SCO-I, SCO-II

NOTE: Type A, Type B, HRCQ, and LSA May At Times Also contain non-excepted quantities of Fissile Radioactive Material Requiring Appropriate Packaging For Nuclear Safety (Criticality Control)

STANDARD REQUIREMENTS
FOR ALL PACKAGES
173.24, 24a, 24b

- No significant release to environment;
- Maintain effectiveness of package - impact resistance, strength, gases;
- No chemical or galvanic corrosion;
- Adequate closures to prevent leakage under normal conditions of transport;
- Must be able to withstand friction and vibration while in transport;
- Metallic devices shall not protrude in a manner likely to cause failure;
- Additional requirements for bulk packages (173.24b).

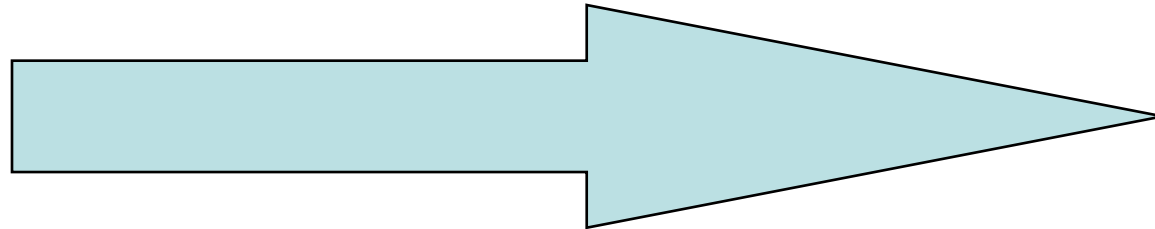
ALL RAM PACKAGES, INCLUDING EXCEPTED, TYPE A ,TYPE B AND IP'S MUST NOW MEET THE:

§173.410-GENERAL DESIGN REQUIREMENTS

Each package used for Class 7 (RAM) Must:

- a. be designed for easy handling and securing ;**
- b. Have any lifting attachments meet certain safety factors;**
- c. Have easily decontaminatable exterior surfaces;**
- d. Have outer layers which avoid collection of water;**
- e. Not have any added features which affect the safety of the package;**
- f. Be capable of withstanding vibration normally incident to transport**
- g. Have physically/chemically compatible materials of construction;**
- h. Have any valves which could release contents secured against unauthorized operation;**
- i. For Transport by air:**
 - (1) surface temperature must not exceed 50 (122 F) ambient**
 - (2) integrity not impaired if exposed to temp range -40 C. to 55 C;**
 - (3) For liquid contents, be capable of withstanding internal pressure that produces pressure differential not less than 85 kPa (13.8 lb/in2).**

The Transport Package Activity Spectrum



Not Regulated as RAM (Exempt)	Excepted Quantity	Type A Quantity	<u>Type B</u> <u>Quantity</u>
Activity concentrations And total consignment Activity not exceeding §173.436	$10^{-2} A_1/A_2$ inst/articles $10^{-3} A_1/A_2$ limited quantities $10^{-4} A_2$ liquids	A_1 or A_2	$>A_1$ or $>A_2$ Highway Route Control Quantity $>3000 \times A_1$ or $>3000 \times A_2$

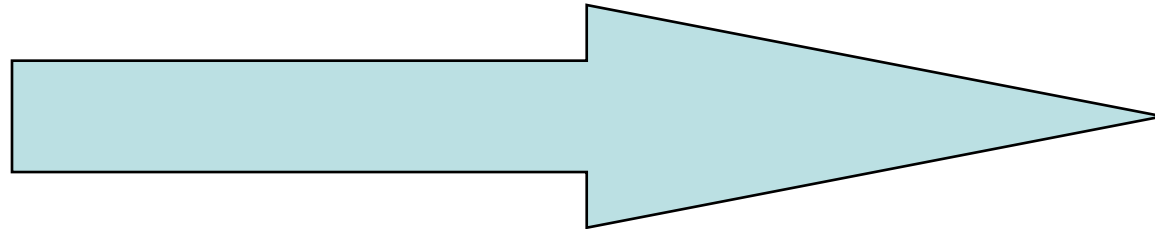
LECTURE 3

RADIOACTIVE MATERIAL PACKAGING

Excepted Packaging

Type A Packaging

The Transport Package Activity Spectrum



Not Regulated as RAM (Exempt)	<u>Excepted Quantity</u>	Type A Quantity	Type B Quantity
Activity concentrations And total consignment Activity not exceeding §173.436	$10^{-2} A_1/A_2$ inst/articles $10^{-3} A_1/A_2$ limited quantities $10^{-4} A_2$ liquids	A_1 or A_2	$>A_1$ or $>A_2$ Highway Route Control Quantity $>3000 \times A_1$ or $>3000 \times A_2$

§173.425, TABLE 4 -ACTIVITY LIMITS FOR LIMITED QUANTITIES, INSTRUMENTS AND ARTICLES

Nature of Contents	Instruments and Articles		Materials Package Limits ¹
	Limits for each instrument or article ¹	Package Limits ¹	
SOLIDS:			
Special form	$10^{-2} A_1$	A_1	$10^{-3} A_1$
Other forms	$10^{-2} A_2$	A_2	$10^{-3} A_2$
LIQUIDS			
-Tritiated Water:			
<0.0037 TBq/L			37 TBq
0.0037 TBq to 0.037 TBq/L			3.7 TBq
> 0.0037 TBq/L			0.037 TBq
-Other Liquids	$10^{-3} A_2$	$10^{-1} A_2$	$10^{-4} A_2$
Gases:			
Tritium ²	$2 \times 10^{-2} A_2$	$2 \times 10^{-1} A_2$	$2 \times 10^{-2} A_2$
Special form	$10^{-3} A_1$	$10^{-2} A_1$	$10^{-3} A_1$
Other forms	$10^{-3} A_2$	$10^{-2} A_2$	$10^{-3} A_2$

¹ For mixtures of radionuclides see 173.433(b)

² These values also apply to tritium in activated luminous paint and tritium adsorbed on solid carriers

EXCEPTED RAM PACKAGE TYPES, PROPER SHIPPING NAMES AND UN NUMBERS

- §173.421 Excepted packages for limited quantities of RAM
PSN: “Radioactive material, excepted package-limited quantity of material”, UN 2910
- §173.424 Excepted packages for radioactive instruments or articles
PSN: “Radioactive material—excepted package, instruments or articles”, UN 2911
- §173.426 Excepted packages for articles containing natural uranium or thorium, PSN: “Radioactive material, excepted package-articles manufactured from natural uranium or depleted uranium or thorium”, UN 2909
- §173.428 Empty Class 7 (Radioactive) materials packaging, PSN: “Radioactive material, excepted package-empty packaging”, UN 2908

GENERIC REQUIREMENTS FOR EXCEPTED PACKAGES- See §§172.422

- Excepted from specification packaging, marking, labeling , **except** :
- Four digit UN ID number (§172.5) must be marked on package,
- Surface radiation levels must not exceed 0.005 mSv/h (0.5 mrem/h)
- Subject to general design requirements of §173.410 (except for empty packages -§173.428)
- Surface contamination limits of §173.443 apply
- Outside of inner package marked RADIOACTIVE, unless no inner packaging, then outer package (except for MT's) must be so marked
- Not more than 15 grams U²³⁵ (except as provided in §173.426)
- If excepted RAM package contents have multiple hazards, §173.423 classification rules may apply
- Excepted RAM packages are excepted from shipping paper and certification requirements , unless also a hazardous waste or hazardous substance

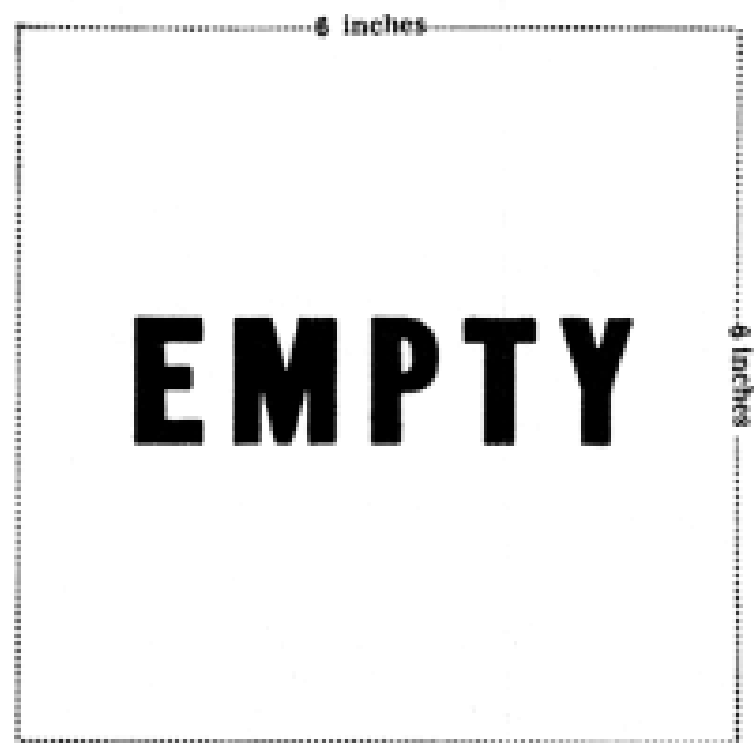
“EMPTY RAM PACKAGES §173.428

- Must be emptied of contents as far “*as far as Practical*”
- Excepted from shipping paper and marking requirements
- **Except** that UN ID # 2908 marking **IS** required
- If U or TH is in the empty package structure it must be covered with inactive sheath of metal or other substantial material
- Rule does not state a limit on activity of **residual** contents
- Internal contamination must not be >100 X §173.443(a)
- EMPTY label (§172.450) must be applied

NOTE: This rule is often not very practical. Measuring the contamination on inside of an empty packaging is often impractical. BUT, If a **reasonable** assessment of the internal residual activity content shows that materials package limit of §173.425, Table 4 is not exceeded, why not use UN #2910 and Proper shipping name “Radioactive material-excepted package, limited quantity of material” without using the EMPTY label

§ 172.450 EMPTY label.

(a) Each EMPTY label, except for size, must be as follows:



(1) Each side must be at least 6 inches (152 mm.) with each letter at least 1 inch (25.4 mm.) in height.

(2) The label must be white with black printing.

(b) [Reserved]



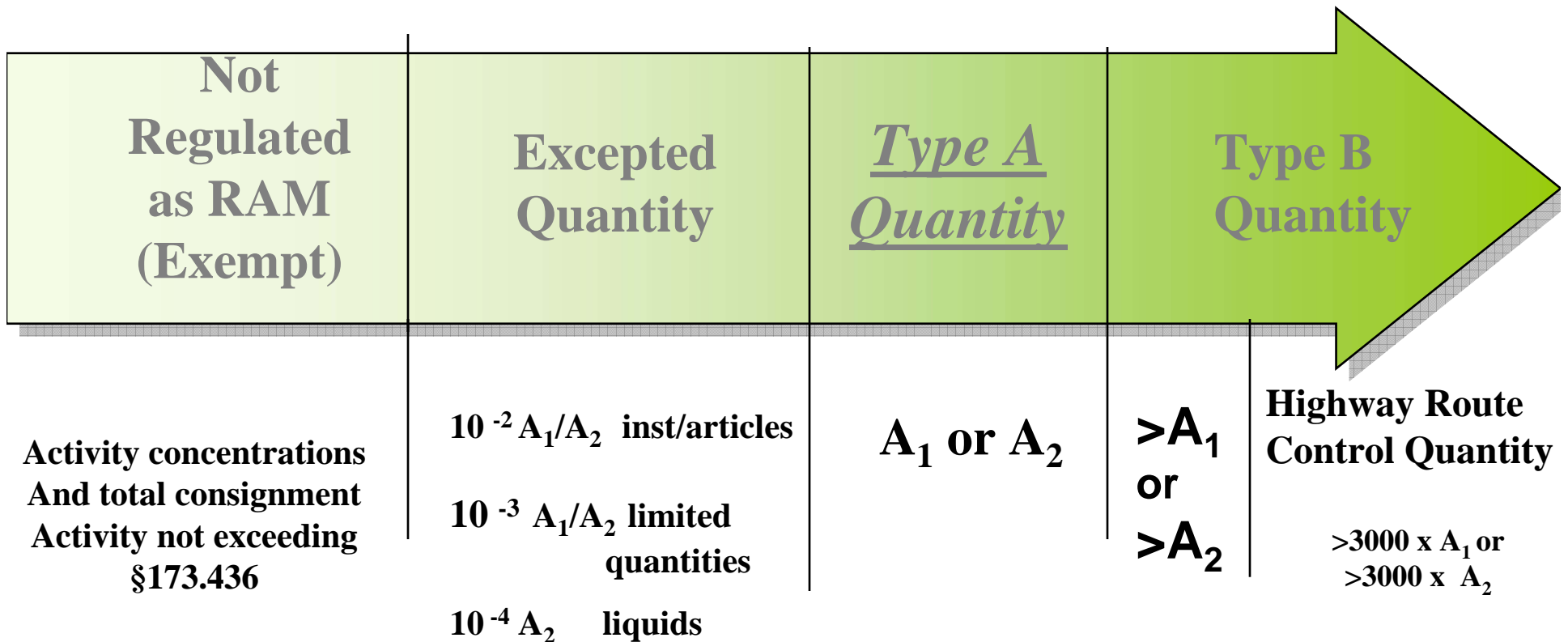
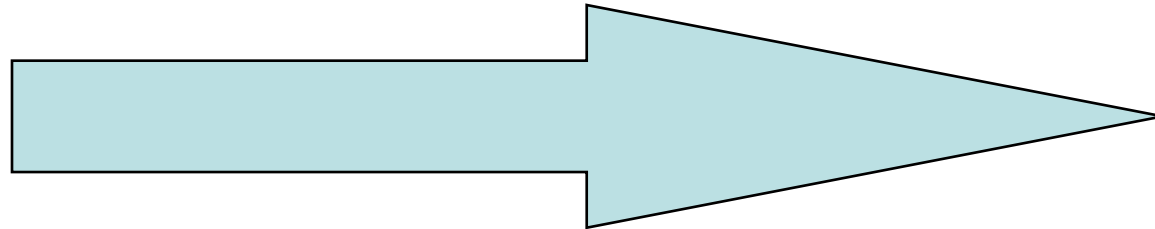


U.S. POSTAL SERVICE RULES FOR ALLOWABLE RADIOACTIVE MATERIAL IN THE US POSTAL SYSTEM

From USPS Publication #52 (1999)

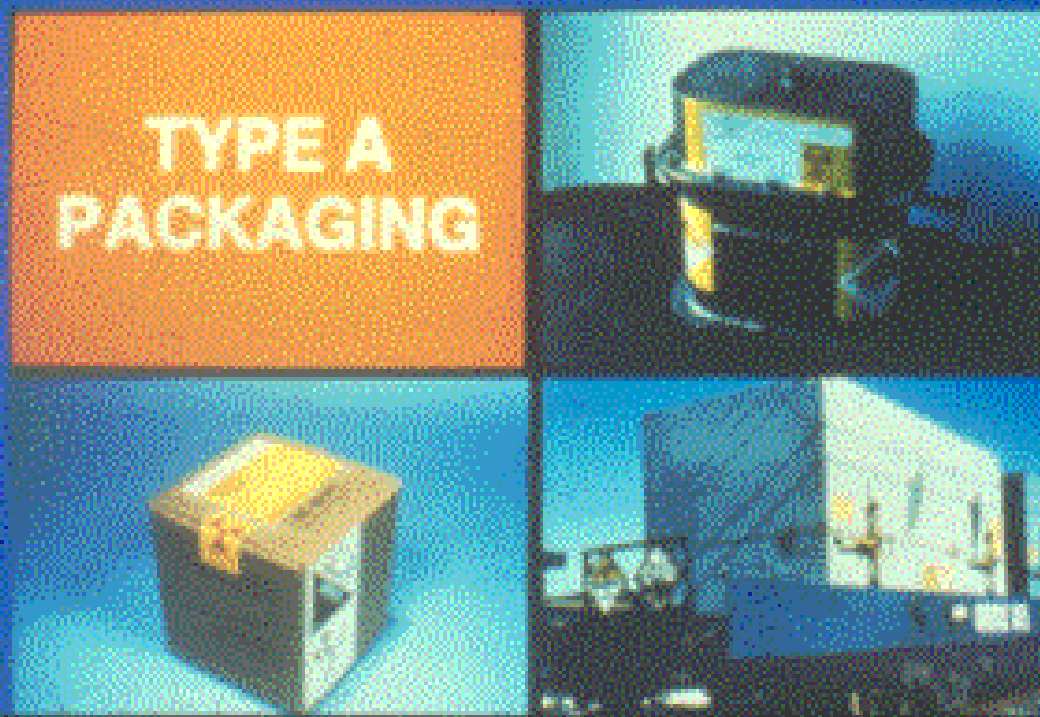
- Radioactive Material Is PROHIBITED From Domestic *or* International Mail By Air *or* Surface Shipment If Required To Bear Either of the Three RADIOACTIVE Category Labels;
- The Only Radioactive Materials Allowable To Be Mailed Are By Domestic Surface Transportation Are Excepted Packages (Excepted From RADIOACTIVE Labels) That Do Not Exceed One-Tenth of The Activity Limits For Excepted Packages As Listed In 49CFR 173.425
- Such Allowable Packages Must Meet All Other DOT Requirements For Excepted Packages (49CFR 173.421-173.426)
- The Outer Surface OF the Mailable Package Must Be Marked With A Certification Statement Similar To That For DOT Excepted Packages

The Transport Package Activity Spectrum



TYPE A — DESIGNED TO CONTAIN AND SHIELD CONTENTS DURING NORMAL AND ROUGH TRANSPORT CONDITIONS

TYPE A PACKAGING



TYPE A PACKAGING

- Required when package activity exceeds excepted quantity limits but does not exceed A_1 or A_2
- Package must be designed and constructed to withstand **Normal Conditions** of transport
- Almost always involves DOT Specification 7A Packaging
- Design is self-approved by user-DOT/NRC do not approve DOT-7A Type A package designs
- *User must document and retain on file supporting safety analysis demonstrating that design complies the performance requirements*

TYPICAL A₁A₂ VALUES-§173.435

RADIONUCLIDE	ELEMENT & ATOMIC NUMBER	A ₁ LIMIT TBq (Ci)	A ₂ LIMIT TBq (Ci)
C ¹⁴	Carbon (6)	40 (1.1x10 ⁻³)	3.0 (81)
Cs ¹³⁷	Cesium (55)	2.0 (54)	0.6 (16)
Ra ²²⁶	Radium (88)	0.2 (5.4)	0.003 (0.081)
Co ⁶⁰	Cobalt (27)	0.4 (11)	0.4 (11)
Ir ¹⁹²	Iridium (77)	1.0 (27)	0.6 (16)
Nat Thorium	Thorium (90)	unlimited	unlimited
Nat Uranium	Uranium (92)	unlimited	unlimited
Uranium (enriched to 20% or less)	Uranium (92)	Unlimited See 173.434 table	Unlimited See 173.434 table
Mo ⁹⁹	Molybdenum 42)	1.0 (27)	0.6 (16)
Pu ²³⁹	Plutonium (94)	10 (270)	0.001 (0.027)

AUTHORIZED TYPE A PACKAGES

§173.415

- DOT Specification 7A, Type A (§173.350)-Shipper must maintain on file the safety analysis documentation of testing and analysis of package design
- Any other Type A package authorized by NRC in §10CFR71 for fissile materials per §173.471
- Any other NRC-certified Type B(U) or Type B(M) Package pursuant to §173.416
- Any foreign-made Type A packaging that meets TS-R-1 standards (*for import into US only*). For subsequent export or domestic use, shipper must obtain from foreign entity and retain on file the "DOT-7A-equivalent" documentation and safety analysis of package or perform and document a safety analysis

TYPE A PACKAGING TESTS*

49 CFR 173.465 AND 10 CFR 71.7

- **WATER SPRAY TEST- SIMULATED RAINFALL OF 5 CM/HR (1.97 IN/HR) FOR ONE HOUR MINIMUM**
- **FREE DROP OF PACKAGE OVER 0.3-1.2 M (1-4 FT) ONTO FLAT HORIZONTAL UNYIELDING SURFACE AFTER WATER SPRAY TEST (DROP HEIGHT BASED ON PACKAGE WEIGHT)**
- **CORNER DROP FROM 0.3 M (0.984 FT) ONTO EACH CORNER IN SUCCESSION (ONLY FOR CERTAIN WOOD OR FIBERBOARD PKGS)**
- **COMPRESSIVE LOAD FOR 24 HOURS FOR PACKAGES WEIGHING UP TO 5000 KG (11,000 LB)**
- **PENETRATION IMPACT OF A SPECIFIED STEEL CYLINDER BAR STRIKING PACKAGE IN MOST VULNERABLE POSITION**
- **ENVIRONMENTAL CONDITIONS (HEAT, COLD, AMBIENT PRESSURE AND TEMPERATURE, VIBRATION, ETC) BEFORE TESTS ARE SPECIFIED. SEPARATE SPECIMENS MAY BE USED FOR FREE DROP, COMPRESSION AND PENETRATION TESTS PROVIDED EACH SPECIMEN FIRST SUBJECTED TO WATER SPRAY**

ADDITIONAL DESIGN REQUIREMENTS **FOR** **TYPE A PACKAGES**

49 CFR 173.412

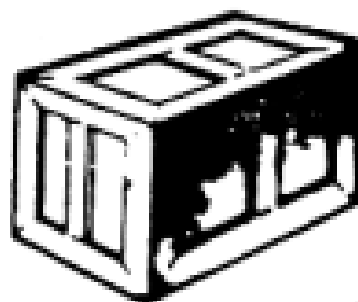
- **Must meet general design requirements in 173.410;**
- **Smallest overall dimension not less than 10 cm (4 inches);**
- **Evidence style seal;**
- **Withstand temperature range of -40°C to 70°C ;**
- **Must be securely closed by a positive fastening device;**
- **Withstand reduction in ambient pressure (3.6 lbs/in^2);**
- **Must pass the performance-oriented TYPE A tests in 173.465.**

TYPICAL TYPE A PACKAGING CONFIGURATIONS

Package Must Withstand Normal Conditions (173.465) of Transport
Only Without Loss or Dispersal of the Radioactive Contents.



Fiberboard Box



Wooden Box



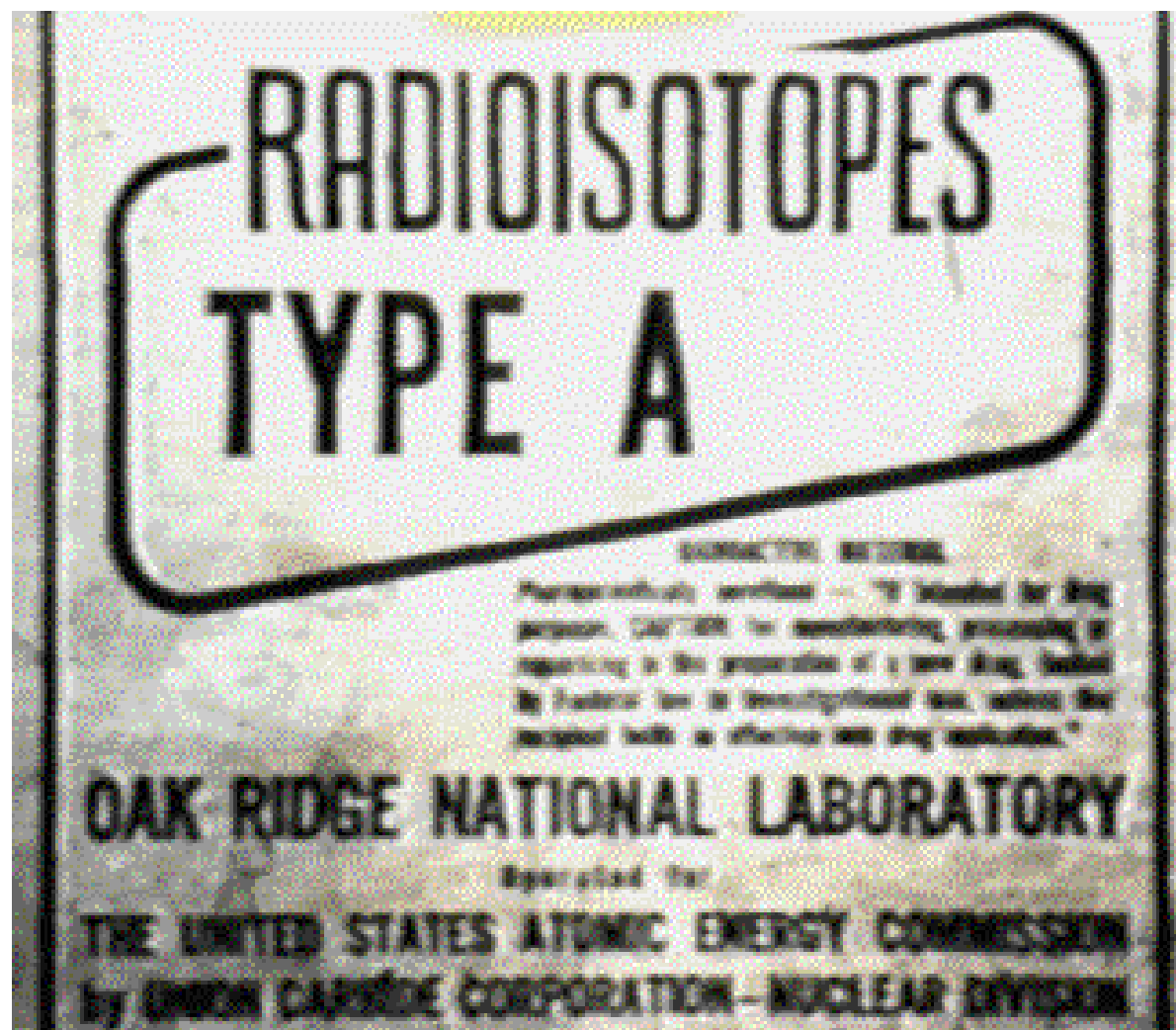
Steel Drum

Typical Schemes
Dot Specification 7A
Type "A" Package

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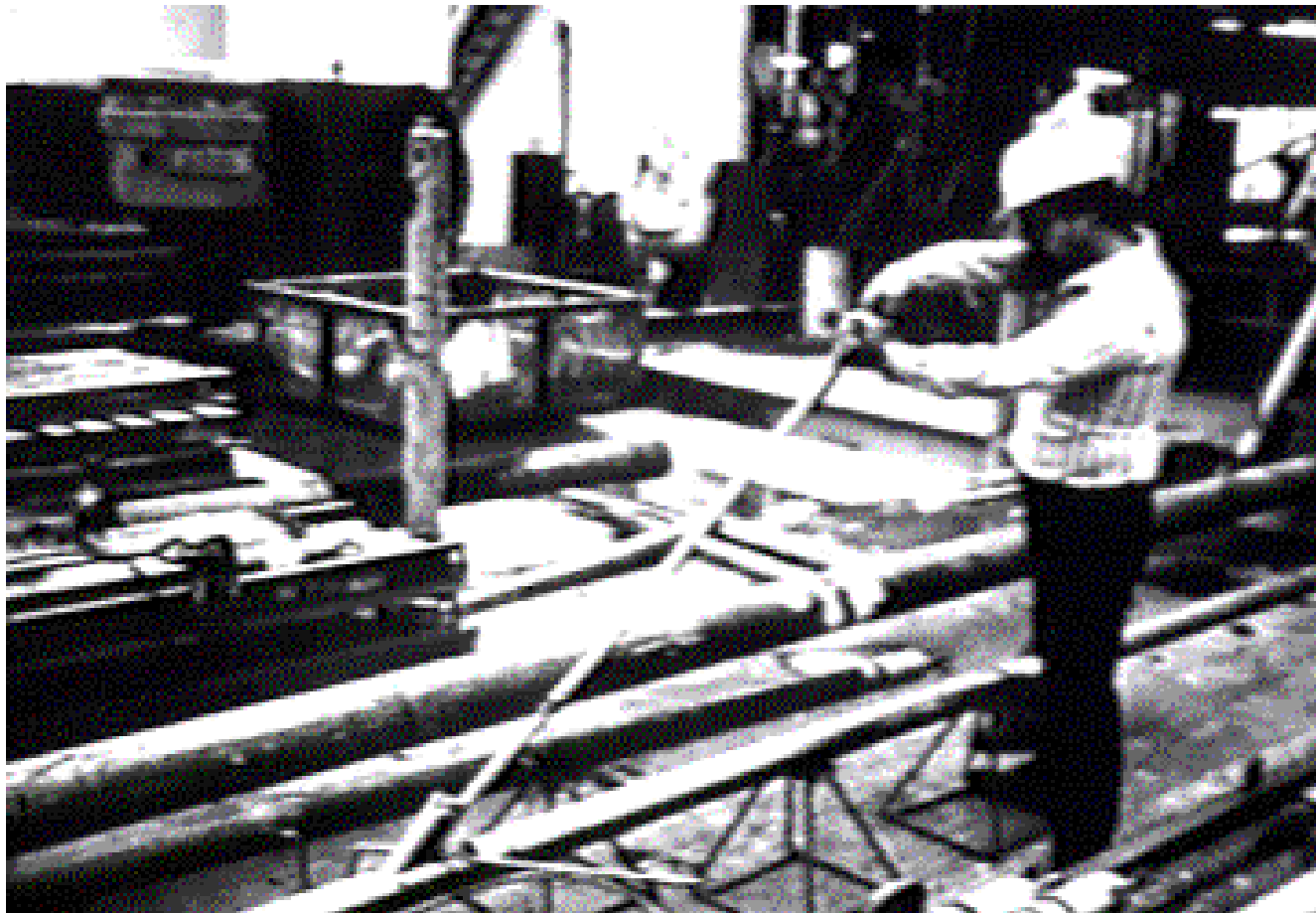
DOE TEST AND EVALUATION DOCUMENT FOR SPECIFICATION 7A TYPE A PACKAGING DOE/RL-96-57, VOLUMES 1 AND 2

- This Test and Evaluation Document for DOT Specification 7A Type A Packaging presents over 300 different ***packagings*** that have been determined to meet the requirements of DOT Specification 7A ***packaging*** per 49 CFR 178.350
- Volume 1 (formerly WHC-EP-0558, Rev 3 and pre HM-169A (1996))
- Volume 2 (Packagings tested and evaluated after April 1, 1996)
- Appendix A is a DOT 7A Type A Packaging Qualification Checklist
- Documents can be obtained on RAMPAC website (rampac.com)

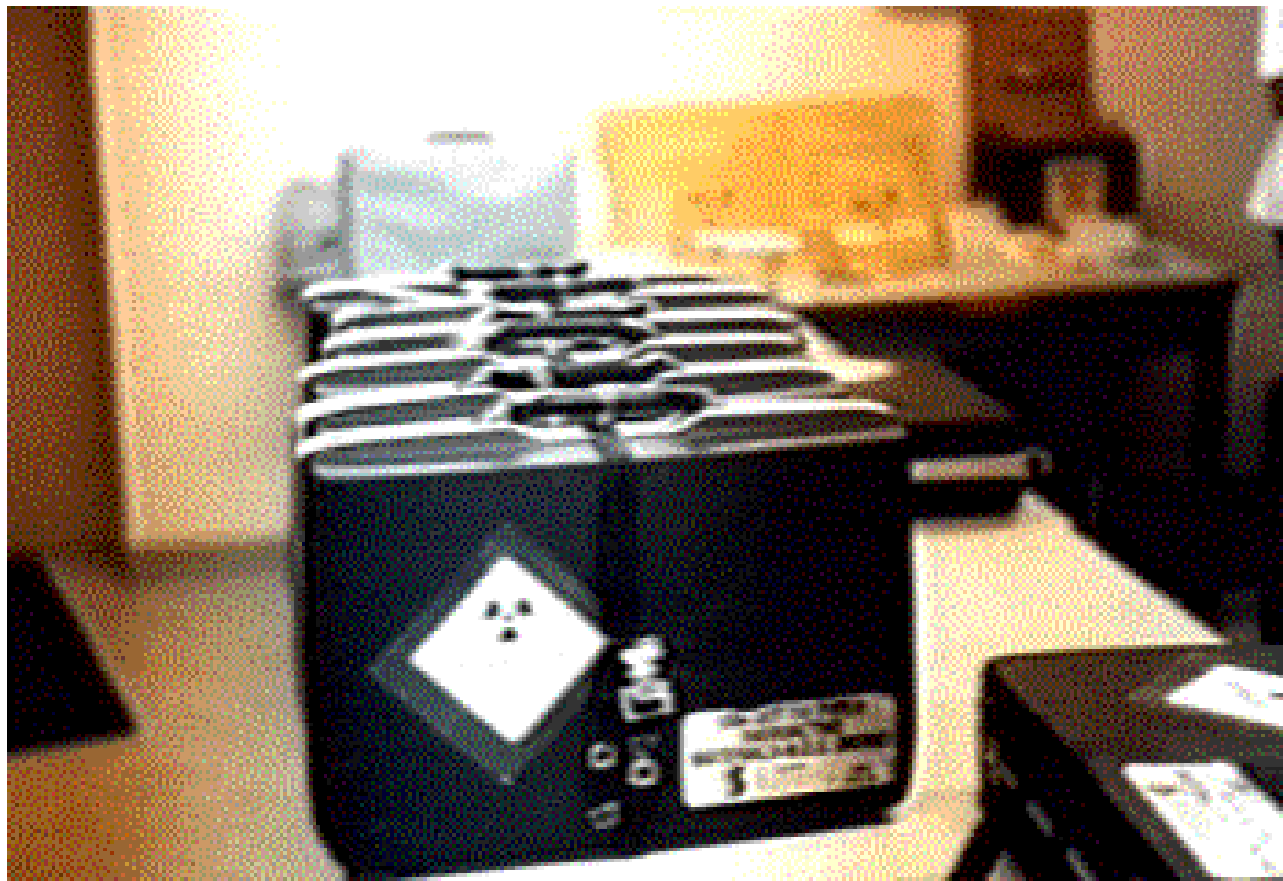












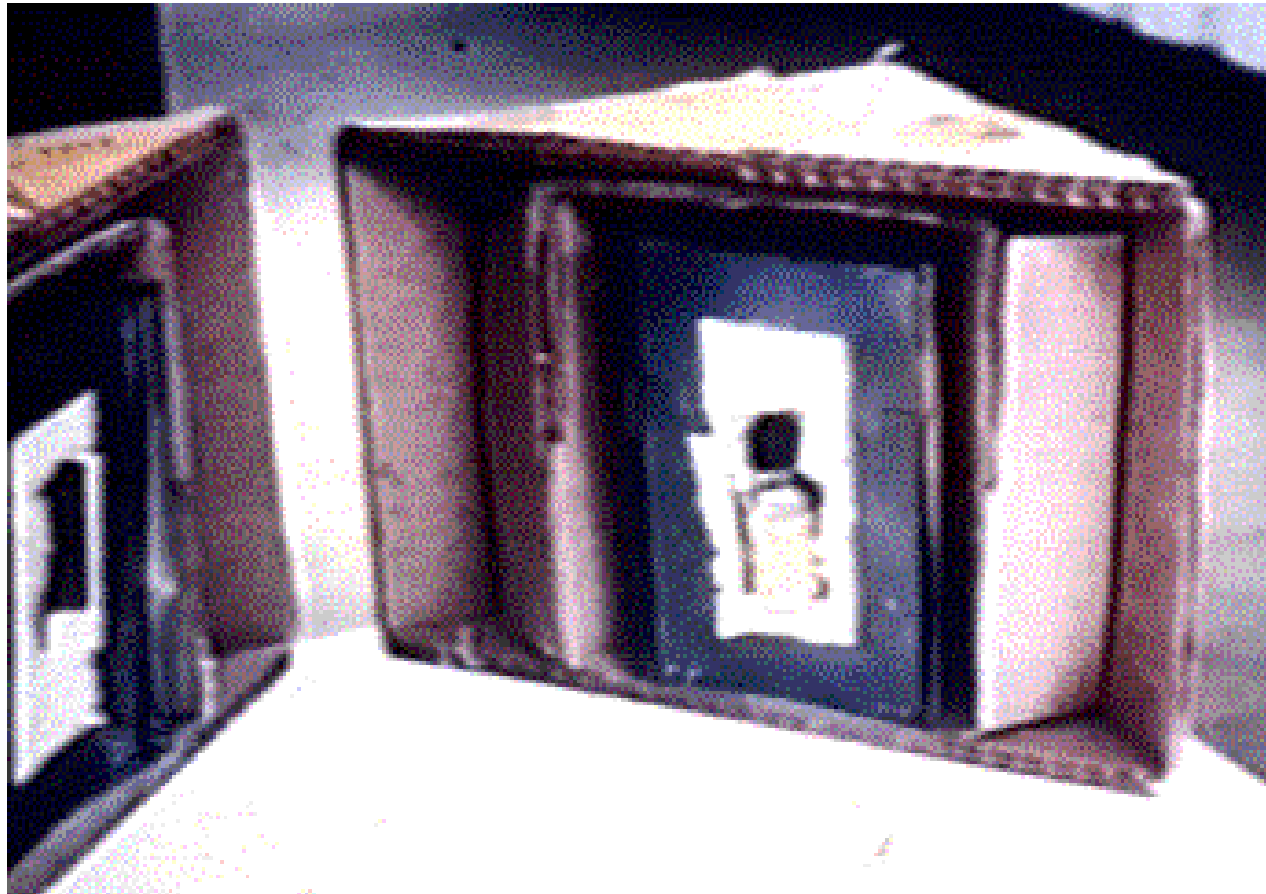






***SPECIAL ADDITIONAL REQUIREMENTS FOR TYPE A PACKAGES
DESIGNED FOR LIQUID CONTENTS
SEE §173.412(k)***

- Sufficient ullage provided to accommodate variations in temperature, dynamic effects and filling dynamics
- Design must have ability to meet regular Type A performance tests of 173.465, plus:
- Package design must also withstand 9 m (30 ft) free drop impact rather than 4 ft drop test, and
- Height of specimen test bar for penetration test is 1.7 m (5.5 ft) rather than 1 m (3.3 ft)
- Must have sufficient absorbent material to take up twice the liquid volume *or* must;
- Be designed to have primary inner and secondary outer containment components



LECTURE 4

HAZARDOUS MATERIALS COMMUNICATIONS REQUIREMENTS-§49 CFR Part 172

List Of Hazardous Materials-§172.101
Shipping Paper Requirements
Marking requirements
Labeling Requirements
Emergency Response Information Requirements
Use of DOT Emergency Response Guide (ERG)
DOT Hazmat Incident Reporting Requirements
DOT Hazmat Employee Training Requirements
Security Plans

NRC Bulletin 79-19 Training For Radwaste
Shippers

10 [C]

LECTURE 4

HAZARDOUS MATERIALS COMMUNICATIONS REQUIREMENTS-§49 CFR PART 172

- **Subpart B-Table of Hazardous Materials-§172.101**
- **Subpart C- Shipping Paper Requirements**
- **Subpart D Marking Requirements**
- **Subpart E-Labeling Requirements**
- **Subpart F-Placarding Requirements**
- **Subpart G-Emergency Response Information and Use of
ERG**
- **Subpart H-Training Requirements**
- **Subpart I- Security Plans**

49 CFR 172 Subpart B (172.101)

Table of Hazardous Materials Descriptions

and

Proper Shipping Names and “UN” Identification Numbers

MAJOR CHANGES TO RAM PROPER SHIPPING NAMES IN §172.101

- Except for Uranium hexafluoride (UF_6), all the former PSN's which were listed by chemical name are now deleted
- The new PSN's which have been added are from TS-R-1 and are packaging oriented per the "schedules" in TS-R-1
- All PSN's , including the two for UF_6 , now start with the words "Radioactive Material"
- Since DOT & NRC did not accept the Type C Package. their PSN's have NOT been included in §172.101
- ERG 2000 fortunately contains the PSN's, UN numbers and ERG references for both before and after HM-230 harmonization with TS-R-1

RAM PROPER SHIPPING NAMES

List 1

Radioactive material, excepted package-limited quantity of material	UN2910
Radioactive material, excepted package-articles manufactured from natural uranium <i>or</i> depleted uranium or natural thorium	UN2909
Radioactive material, Radioactive material-excepted package-empty packaging	UN2908
Radioactive material, excepted package-instruments or articles	UN2911
Radioactive material, low specific activity (LSA-I) <i>non Fissile or fissile excepted</i>	UN2912

RAM PROPER SHIPPING NAMES

List 2

Radioactive material, low specific activity (LSA-II), <i>non fissile or fissile excepted</i>	UN3321
Radioactive material, low specific activity (LSA-III), <i>non fissile or fissile excepted</i>	UN3322
Radioactive material, surface contaminated objects (SCO-I or SCO-II) non fissile or fissile excepted	UN2913
Radioactive material, transported under special arrangement, non fissile or fissile-excepted	UN2919
Radioactive material, transported under special arrangement-fissile	UN3331

10 49

RAM PROPER SHIPPING NAMES

List 3

Radioactive material, Type A package, fissile <i>non special form</i>	UN3327
Radioactive material, , Type A package, non special form , <i>non fissile or fissile excepted</i>	UN2915
Radioactive material, Type A package, special form, fissile	UN3333
Radioactive material, Type B(M) package, fissile	UN3329

RAM PROPER SHIPPING NAMES

List 4

Radioactive material, Type B(M) package, <i>non fissile or fissile excepted</i>	UN2917
Radioactive material, Type A package, special form, <i>non fissile or fissile excepted</i>	UN3332
Radioactive material, Type B(U) package, fissile	UN3328
Radioactive material ,Type B(U) package, <i>non fissile or fissile excepted</i>	UN2916
Radioactive material, uranium hexafluoride, <i>non fissile or fissile excepted</i>	UN2978
Radioactive material, uranium hexafluoride, fissile	UN2977

49 CFR PART 172

Subpart C

Shipping Papers

Definition of a Shipping Paper

As used in the HMR, "shipping paper" means a shipping order, bill of lading, manifest, or other shipping document serving a similar purpose and containing the information required by 172.202, 172.203, and 172.204.

Shipping papers must be retained for 375 days by the offeror and carrier. This requirement went into effect on August 12, 2002. To learn more about this requirement refer to Docket Number HM-207B, *Hazardous Materials: Retention of Shipping Papers*, Final rule; published 07/12/02; 67 Federal Register 46123; and Final rule; published 11/01/02; 67 Federal Register 66571. Links to the Federal Register can be found by visiting RSPA's website at: www.rspa.dot.gov.



Documents and Forms

Except for a hazardous waste, there is no specific shipping paper "form" required for a hazardous material shipment. A shipper may use a shipping paper appropriate to its operation.



§172.202 Basic Descriptions On Shipping Papers For All Hazardous Material

- Proper shipping name (PSN) from column 2 of the table in §172.101
- Hazard Class or Division-not required for RAM since all RAM PSN's now begin with words "Radioactive material"
- RQ notation if a Reportable Quantity per Table 1 Or 2 of Appendix to §172.101 (Table 2 is radionuclide RQ list). Must be entered before or after PSN
- Emergency Response Telephone Number per §172.604(a)(3)

49 CFR PART 172.203(d)

Additional Shipping paper descriptions for RAM

- Name of each radionuclide- for mixtures see formulas §173.433(f) , use of abbreviations or symbols are OK; e.g. U^{235} , Co^{60} , etc
- Physical and chemical form, if non-special form, generic name is OK
for chemical form
- Activity of each package in SI units-"curie"units OK in brackets after SI
- Category of label on each package, e.g. RADIOACTIVE-WHITE I, etc
- Words "Fissile excepted" if excepted per §173.453, or
- The Criticality Safety Index (CSI) assigned for each non-excepted fissile package
- For NRC or DOE approved packages, notation of Certificate Identification
- For export or foreign approved packages, notation of package identification in the applicable IAEA Certificate of Competent Authority
- Notation of "Exclusive Use" shipment if shipment required to be exclusive use
- "Highway Route Controlled Quantity" or "HRCQ" if a HRCQ shipment
- "Offerer's" (Shipper's) certification per §172.204

Shippers Certification §172.204

- “This is to certify that the above named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation

NOTE: Shipper certification is not required when carriage is by a shipper acting as a private carrier **unless** the material is Hazardous Waste or is a hazardous material that is to be reshipped or transferred from one carrier to another

LISTING RADIONUCLIDES ON SHIPPING PAPERS AND LABELS

49 CFR 173.433(f)

"95% RULE"

$$\sum_{i=1}^n \frac{a_{(i)}}{A_{(i)}} \geq 0.95 \sum_{i=1}^{n+m} \frac{a_{(i)}}{A_{(i)}}$$

n = do list

m = do not list

n + m = total of all radionuclides present

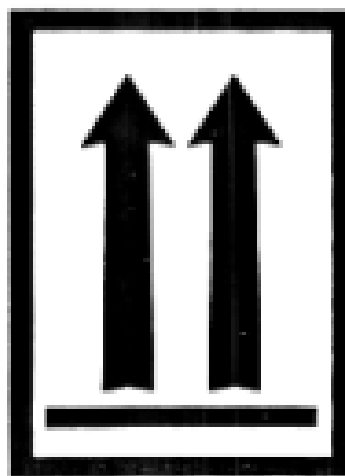
Required Markings For Radioactive Materials §§172.304,172.310

- Proper Shipping Name from Table in §172.101
- 4-Digit UN Identification Number from Table in §172.101
(Also required *now* for excepted packages per §173.422(a))
- RQ if a Reportable Quantity per Table 2 Appendix to §172.101
- Gross weight if greater than 50 kg (110 lb)
- TYPE A; TYPE B(U); TYPE B(M); TYPE IP-1; TYPE IP-2; OR TYPE IP-3 (13 mm (0.5 in) high letters) as applicable to the packaging
- Durable & fire-resistant, embossed Radiation Symbol on outermost surface, if a Type B(U) or Type B(M) package
- If an NRC, DOE, or DOT revalidated foreign package. The package identification marking as designated in the applicable certificate or revalidation document
- Consignee or consignor's name and address
- Upward orientation double arrows if liquid contents (§172.312)

49 CFR PART 172

Subpart D

MARKING



Package orientation



49 CFR PART 172

Subpart E

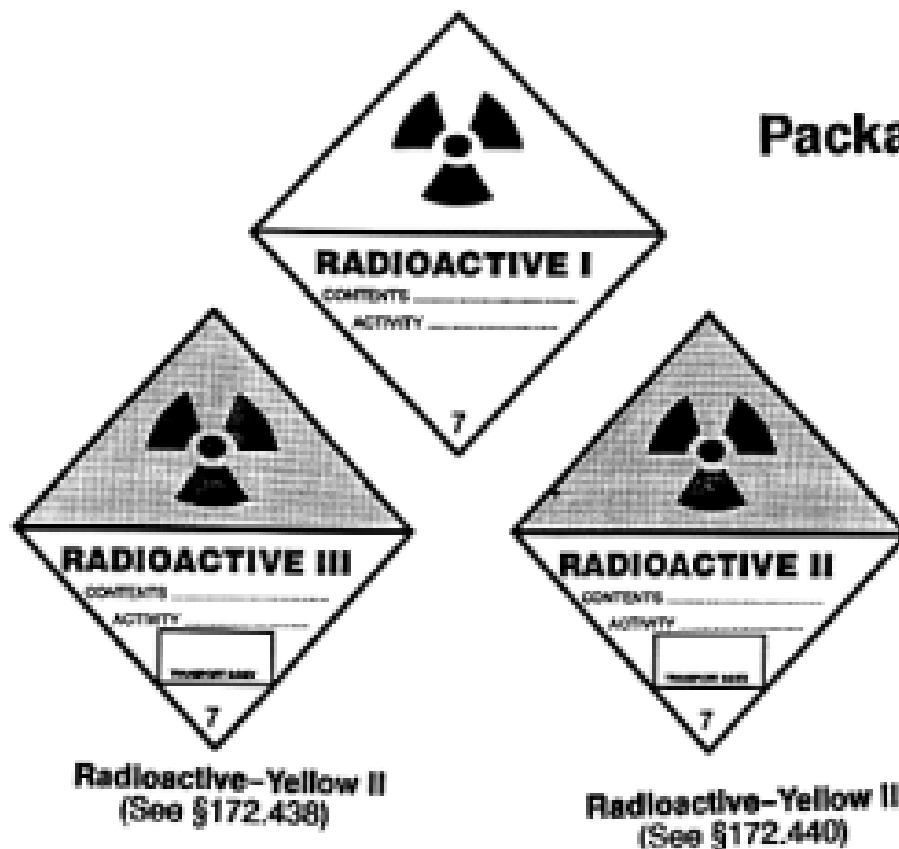
Labeling

RADIOACTIVE MATERIAL LABELING

- RADIOACTIVE WHITE-I, RADIOACTIVE YELLOW-II, OR RADIOACTIVE YELLOW-III required on package, unless excepted, based on maximum surface radiation level and transport index per Table in §172.403
- Format and specs for labels §§172.407 & 172.436-172.440
- Two labels required, one each on opposite sides of package
- Names of nuclides entered on "**contents**" line-for listing of mixtures, refer to formula in §173.433(f)
- "**activity**" entered in SI units with former "curie" units optional in brackets after the required SI units
- **Transport Index (TI)** in block in lower half of Yellow II or -III
- If dimensions permit, one label is placed near PSN marking
- "7" for hazard class preprinted on lower corner of label

Radioactive-White I
(See §172.436)

Package Labels

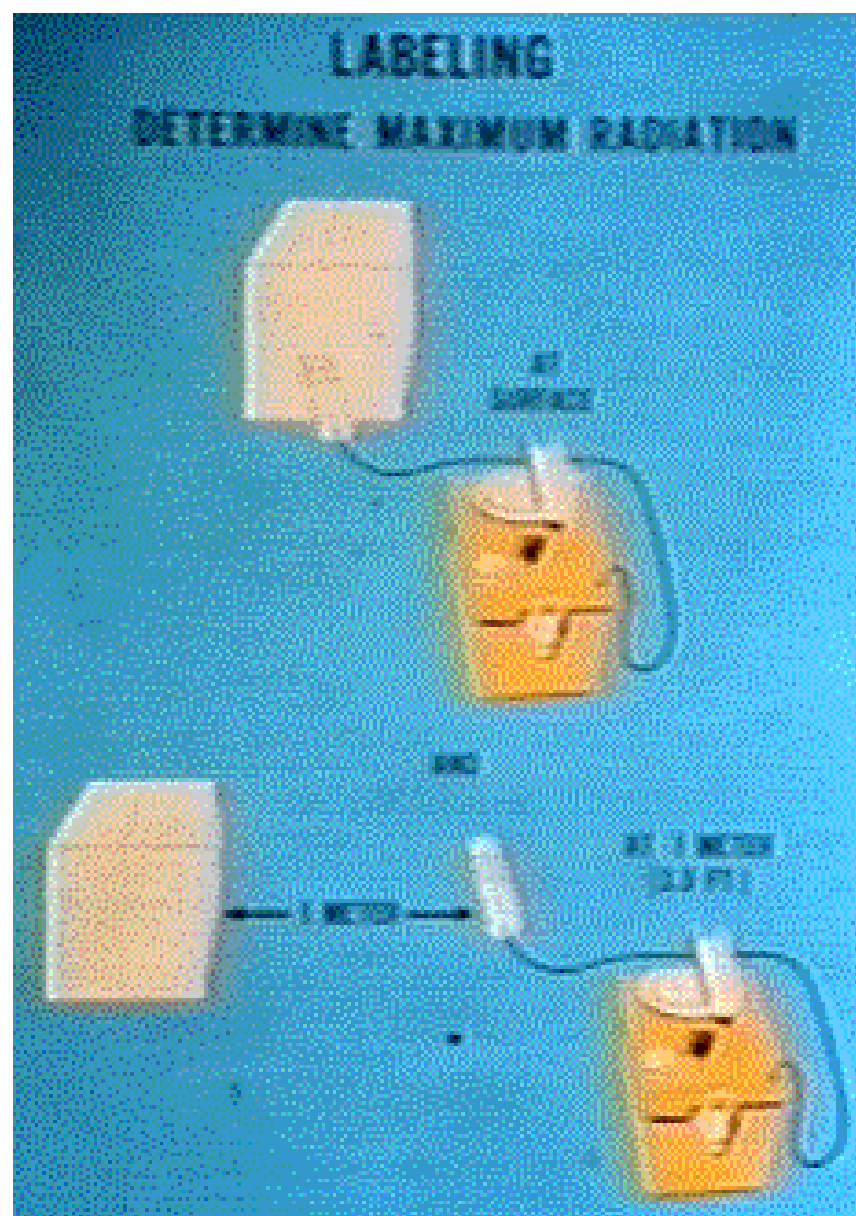


For all labels, vertical bars on each label are in red. Each label is diamond-shaped, four inches on each side, and has a black solid-line border one-fourth inch from the edge. The background color of the upper half (within the black line) is white for the "I" label. It is yellow for the "II" and "III" labels.

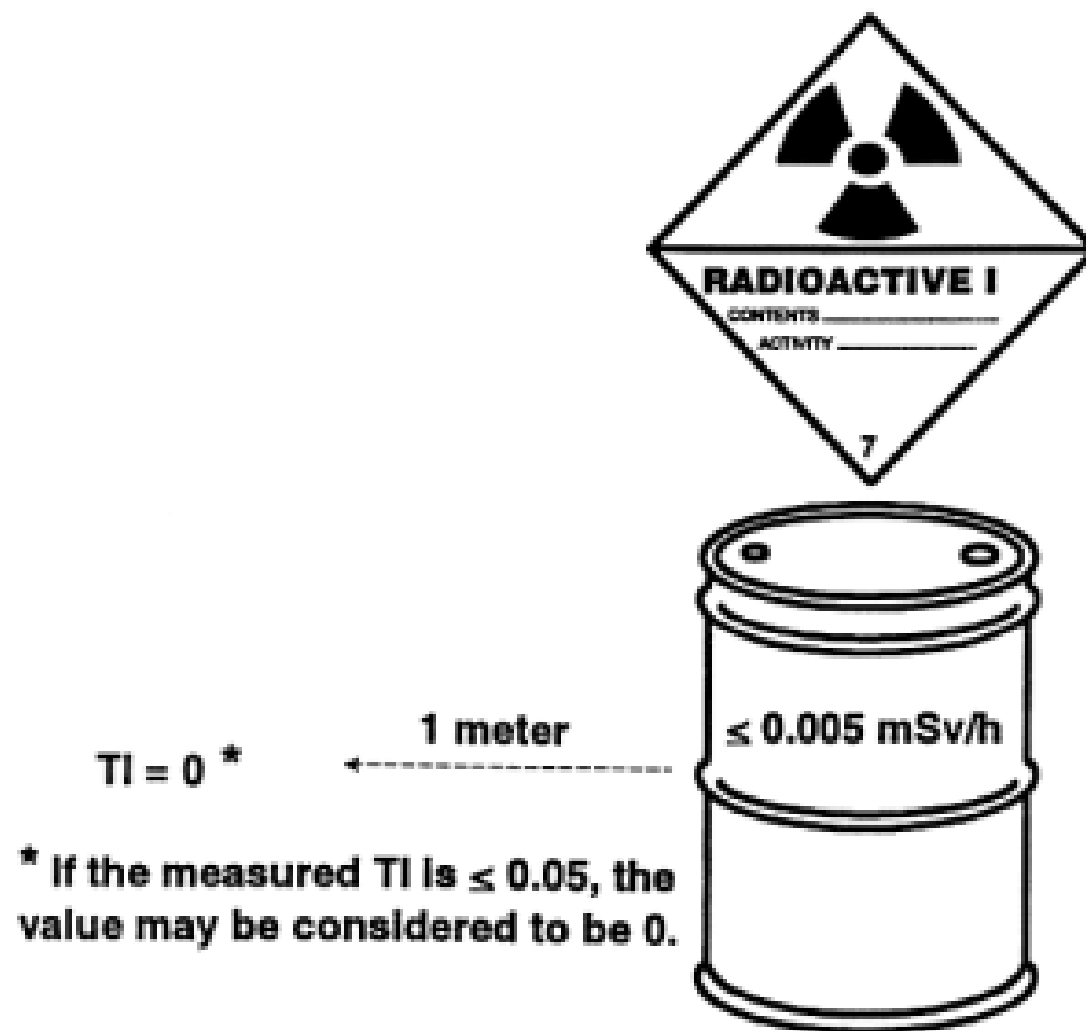


RAM LABELING TABLE BASED ON T.I. AND
SURFACE DOSE RATE-§172.403

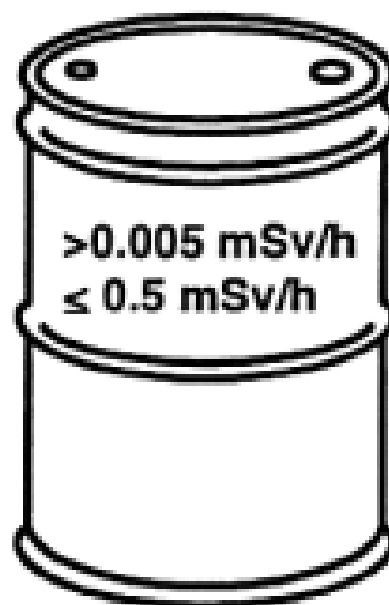
TRANSPORT INDEX	MAXIMUM DOSE RATE @ ANY POINT ON PACKAGE SURFACE	LABEL CATEGORY
0	Less than or equal to 0,005 mSv/h (0.5 mrem/h)	WHITE -I
> 0 but not > 1	Greater than 0.005 mSv/h (0.5 mrem/h) but less than or equal to 0.5 mSv/h (50 mrem/h)	YELLOW-II
➤1, but not > 10	Greater than 0.5 mSv/h (50 mrem/h) but less than or equal to 2 mSv/h (200 mrem/h)	YELLOW-III
>10	Greater than 2 mSv/h (200 mrem/h) but less than or equal to 10 mSv/h (1,000 mrem/h)	YELLOW-III (Must be exclusive use, closed transport vehicle)



Radioactive White-I Label



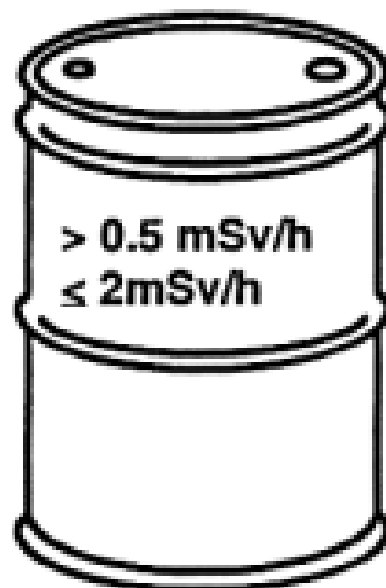
Radioactive Yellow-II Label



1 meter

$TI > 0 \leq 1$

Radioactive Yellow-III Label



1 meter

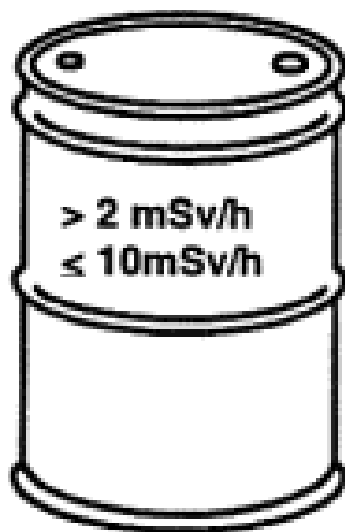
$TI > 1 \leq 10$

Radioactive Yellow-III Label



closed

Must be shipped under exclusive use controls per 173.441(b).



1 meter

TI > 10

THE NEW FISSILE RADIOACTIVE LABEL TO BE USED IN CONJUNCTION WITH THE “CRITICALITY SAFETY INDEX”

[See page 59 of IAEA TS-R-1 (formerly ST-1)]

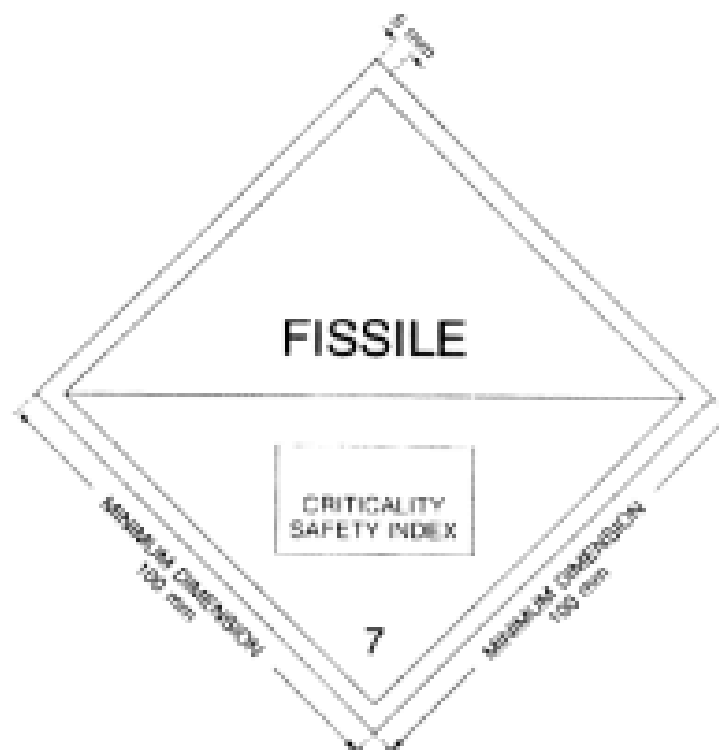


FIG. 9 Criticality safety index label. The background colour of the label shall be white; the colour of the printing shall be black.

49 CFR PART 172

Subpart F

Placarding



PROVIDING AND AFFIXING PLACARDS

172.506

- (a) Each person offering a motor carrier a hazardous material for transportation by highway shall provide to the motor carrier the required placards for the material being offered prior to or at the same time the material is offered for transportation, unless the carrier's motor vehicle is already placarded for the material as required by the Subpart.
 - 1) No motor carrier may transport a hazardous material in a motor vehicle, unless the placards required for the hazardous material are affixed thereto as required by this Subpart.

"The Standard"

Placard any quantity of hazardous material on each end and each side of the container or vehicle.



172.504(a)

PLACARDING

49 CFR 172.500

- Radioactive Yellow III labels on packages
- LSA or SCO Exclusive Use
- Special placards for HRCQ
- Four sides of vehicle
- > 3 inches from other markings
- No obstructions
- Read left to right horizontally
- Size and design specifications

← Carrier

← Shipper

Illustrations of Two Radioactive Shipment Placards

Vehicle Warning Placard



Special Placard for Highway
Route Controlled Quantities



Placards like these are used to identify radioactive shipments.

(The background color for the black trefoil in the upper half of this 12" x 12" placard is yellow.)



PLACARDS APPLIED BY CARRIERS



IF ANY PACKAGES WITH:

Radioactive-White I
(See §172.436)



Radioactive-Yellow II
(See §172.438)



NO PLACARDS REQUIRED

IF ANY PACKAGES WITH:

Radioactive-Yellow III
(See §172.440)



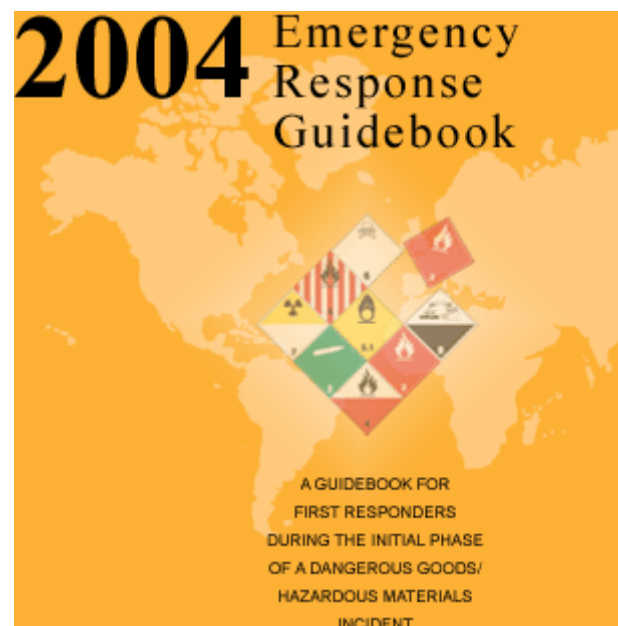
PLACARDS REQUIRED

49CFR PART 172-SUBPART G

EMERGENCY RESPONSE INFORMATION REQUIREMENTS

- 172.602-SETS FORTH THE MINIMUM REQUIREMENTS FOR PROVIDING EMERGENCY RESPONSE MITIGATION INFORMATION ON SHIPPING PAPERS-NOW INCLUDES THE TECHNICAL NAME OF THE MATERIAL. INFO MUST BE KEPT ON BOARD VEHICLES AND AT ALL LOCATIONS HAZMAT IS HANDLED IN TRANSP.
- 172.604-REQUIRES SHIPPER TO PROVIDE AN EMERGENCY RESPONSE TELEPHONE NO. WHICH MUST BE MONITORED AT ALL TIMES HAZMAT IS IN TRANSP. IT MUST BE NO. OF A PERSON WHO IS EITHER KNOWLEDGABLE OF OR HAS ACCESS A PERSON HAVING THE APPLICABLE EMERGENCY RESPONSE MITIGATION INFORMATION
- TELEPHONE NO MAY BE THAT OF AN AGENCY WHICH IS CAPABLE OF AND AGREES TO FURNISH THE INFO, SUCH AS "CHEMTREC",BUT SHIPPER MUST REGISTER WITH AND FURNISH TO THAT AGENCY THE SPECIFIC INFORMATION ON THE HAZMAT BEING TRANSPORTED

NEW DOT RULES, DOCKET HM-126C, EFF: DEC 31,1990



ERG 2004 CHANGES FOR RADIOACTIVE MATERIALS

- ERG 2004 only place where ERG's found
- Part 172.101 contains UN Numbers
- No new RAM ERGs
- Still have ERG's 161-166 for RAM
- Have a number of new UN Numbers
- UN number assignments follow:

**ERG 161 RADIOACTIVE MATERIAL
(LOW-LEVEL RADIATION)
USED WITH UN NUMBERS :**

2908

2909

2910

2911

**ERG 162 RADIOACTIVE MATERIAL
(LOW TO MODERATE RADIATION)
USED WITH UN NUMBERS:**

2912

2913

3321

3322

**ERG 163 RADIOACTIVE MATERIAL
(LOW TO HIGH LEVEL RADIATION)
USED WITH UN NUMBERS:**

2915

2916

2917

2982

3323

3332

- **ERG 164 RADIOACTIVE MATERIAL**
- **(SPECIAL FORM/LOW TO HIGH LEVEL RADIATION**
- **USED WITH UN NUMBERS:**
- **2874**

- **ERG 165 RADIOACTIVE MATERIALS**
- **(FISSILE/LOW TO MODERATE RADIATION)**
- **USED WITH UN NUMBERS:**
- **2918 3329**
- **3324 3330**
- **3225 3328**
- **3326 3331**
- **3327 3333**

- **ERG 166 RADIOACTIVE MATERIALS-CORROSIVE**
- **(URANIUM HEXAFLUORIDE/WATER SENSITIVE)**
- **USED WITH UN NUMBERS:**
- **2977**
- **2978**

HAZARDOUS MATERIALS TRANSPORTATION INCIDENT REPORTING REQUIREMENTS

Located in 49 CFR at:

§ 171.15 Immediate Notice of Certain Hazardous Materials Incident

§ 171.16 Detailed Hazardous Materials Incident Reports

IMMEDIATE NOTIFICATION OF ACCIDENT OR SPILL:

In the U.S.A., any carrier involved in any accident
in which as a direct result of hazardous materials/
dangerous goods:

- (a) A person is killed;
- (b) An injured person requires hospitalization;
- (c) Carrier or other property damage exceeds \$50,000;
- (d) Fire, breakage, spillage, or suspected radioactive contamination involving a shipment of radioactive materials;
- (e) Fire, breakage, spillage, or suspected contamination occurs involving a shipment of an etiologic agent or infectious substance; or
- (d) or a continuing danger to life exists at the scene of an incident;

HAZARDOUS MATERIALS TRANSPORTATION INCIDENT REPORTING REQUIREMENTS

Located in 49 CFR at:

§ 171.15 Immediate Notice of Certain Hazardous Materials Incident

§ 171.16 Detailed Hazardous Materials Incident Reports

(CONTINUED)

The carrier must notify the D.O.T. immediately by telephone at **1-800-424-8802** (toll-free) and, for etiologic agents/infectious substances, the Director, Center for Disease Control, U.S. Public Health Service Atlanta, Georgia, at 1-404-633-5313.

The carrier must notify the D.O.T. immediately by telephone at **1-800-424-8802** (toll-free) and, for etiologic agents/infectious substances, the Director, Center for Disease Control, U.S. Public Health Service Atlanta, Georgia, at 1-404-633-5313.

The Required information for telephone notification must include:

- (1) Name of person making the report.
- (2) Name & address of carrier represented by the reporter.
- (3) Phone number where reporter may be contacted.
- (4) Date, time, and location of the incident.
- (5) The extent of injuries, if any.
- (6) Classification, name, and quantity of the hazardous material/dangerous goods involved, if the information is available.
- (7) Type of incident and nature of hazardous material involvement, and whether a continuing danger to life exists at the scene.

THE CARRIER IS ALSO REQUIRED TO FILE A WRITTEN FOLLOW-UP WITH THE F-5800.1 FORM WITHIN 15 DAYS OF THE INCIDENT.

2. DETAILED HAZARDOUS MATERIALS/DANGEROUS GOODS INCIDENT REPORTS:

Within 15 days after the discovery of an unintentional release of hazardous materials/dangerous goods, the carrier or temporary storage facility must file a detailed written report (DOT FORM F-5800.1) to:

Information Systems Manager
Research and Special Programs Administration
Department of Transportation
Washington, D.C. 20590

DOT HAZMAT EMPLOYEE TRAINING REQUIREMENTS

FOUND AT §49 CFR 172, SUBPART H

"HAZMAT EMPLOYEES" ARE REQUIRED TO BE TRAINED :

WITHIN 90 DAYS AFTER EMPLOYMENT OR CHANGE IN JOB FUNCTION

RECURRENT TRAINING TO BE PROVIDED AT LEAST ONCE EVERY 3 YEARS

REQUIRED COMPONENTS OF HAZMAT EMPLOYEE TRAINING INCLUDE:

GENERAL AWARENESS AND FAMILIARIZATION WITH HAZMAT REGULATIONS;

FUNCTION-SPECIFIC TRAINING;

SAFETY TRAINING, TO INCLUDE:

EMERGENCY RESPONSE REQUIREMENTS OF §49 CFR 172, SUBPART G
MEASURES TO PROTECT FROM HAZARDS OF SPECIFIC MATERIAL HANDLED;
SAFETY TRAINING TO PREVENT INDUSTRIAL ACCIDENTS

RECORDS OF HAZMAT EMPLOYEE TRAINING TO BE MAINTAINED BY HAZMAT EMPLOYER

RECORDS MUST INCLUDE:

EMPLOYEE'S NAME;

DATE OF MOST RECENT TRAINING COMPLETED;

DESCRIPTIO (COPY) OF TRAINING MATERIALS USED;

NAME/ADDRESS OF PERSON PERFORMING THE TRAINING;

CERTIFICATION BY HAZMAT EMPLOYER THAT HAZMAT EMPLOYEE HAS BEEN TRAINED AND
TESTED (REGS DO NOT SPECIFY THAT TESTING BE WRITTEN).



BULLETIN 79-18
NRC REQUIREMENT FOR
TRANSPORTATION TRAINING

ISSUED AUGUST 10, 1979

**NRC BULLETIN 79-18 FIRST ESTABLISHED REQUIREMENT FOR
TRAINING OF LICENSEE EMPLOYEES ON DOT REGULATIONS**

ACTIONS REQUIRED OF LICENSEES:

MAINTAIN CURRENT SET OF DOT 49 CFR REGULATIONS;

**MAINTAIN CURRENT SET OF WASTE BURIAL FACILITIES*
REQUIREMENTS;**

**DESIGNATE, IN WRITING, PERSONS RESPONSIBLE FOR
WASTE TRANSPORTATION PROGRAM;**

**PROVIDE MANAGEMENT-APPROVED INSTRUCTIONS AND
PROCEDURES FOR WASTE TRANSPORTATION;**

PROVIDE TRAINING TO INVOLVED PERSONS;

**IMPLEMENT MANAGEMENT PROGRAM FOR AUDITING OF
WASTE TRANSPORTATION PROGRAM**

LECTURE 5

MISCELLANEOUS MATTERS AND SUMMARY

Type B Packaging

Fissile Materials shipments

Low Specific Activity (LSA)

Surface Contaminated Objects (SCO)

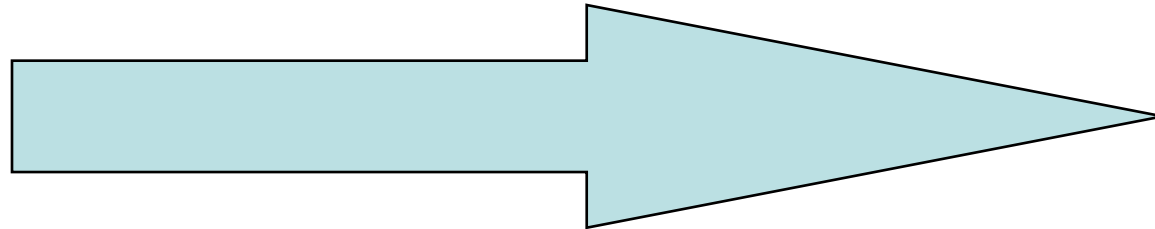
Industrial Packaging IP-1, IP-2, IP-3

Recap of Major DOT (HM-230) Amendments

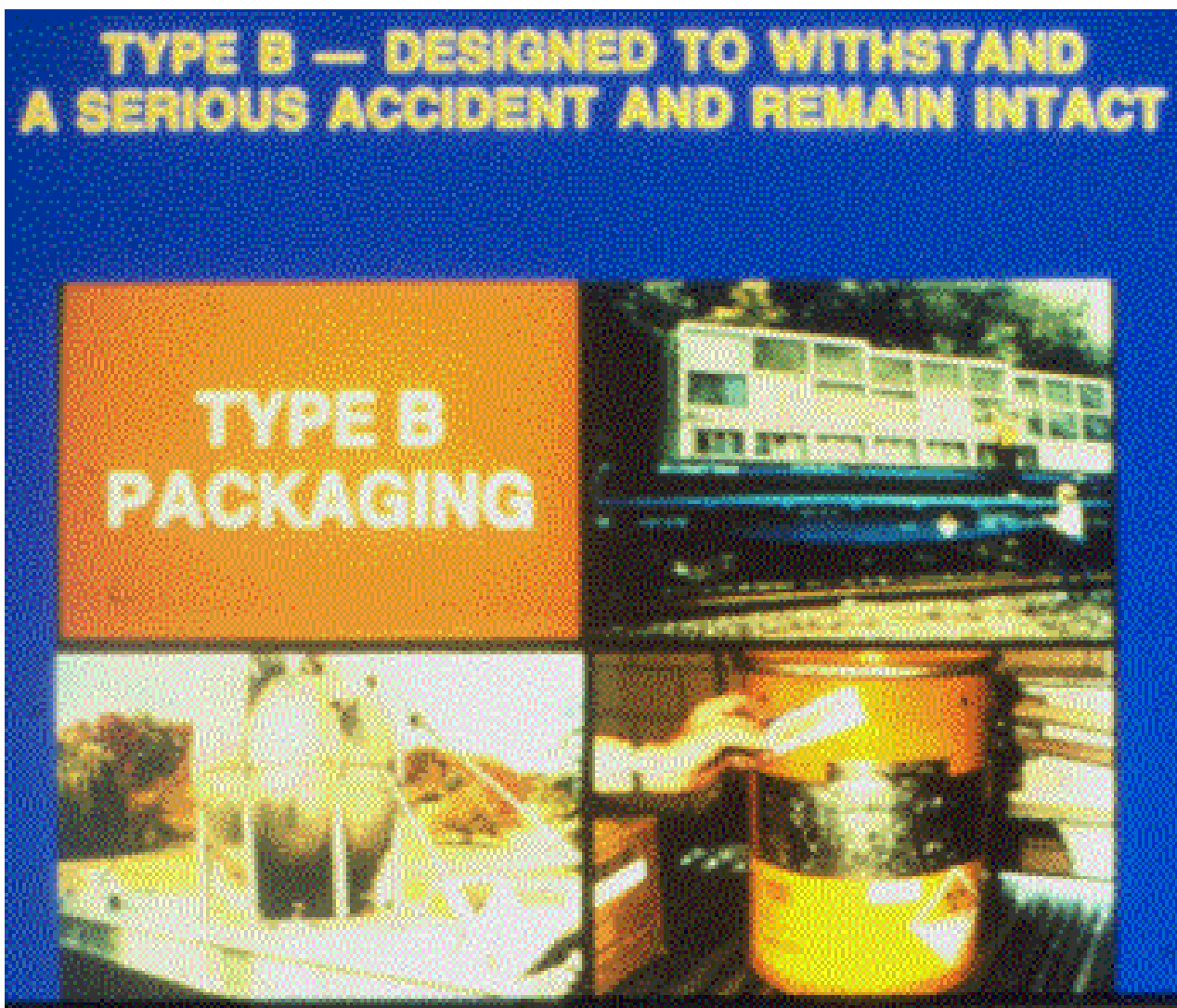
Recap of a few NRC Part 71 Amendments

Questions and Answers

The Transport Package Activity Spectrum



Not Regulated as RAM (Exempt)	Excepted Quantity	Type A Quantity	<u>Type B</u> <u>Quantity</u>
Activity concentrations And total consignment Activity not exceeding §173.436	$10^{-2} A_1/A_2$ inst/articles $10^{-3} A_1/A_2$ limited quantities $10^{-4} A_2$ liquids	A_1 or A_2	$>A_1$ or $>A_2$ Highway Route Control Quantity $>3000 \times A_1$ or $>3000 \times A_2$



TYPE B PACKAGING TESTS •

10 CFR 71.73 (HYPOTHETICAL ACCIDENT CONDITIONS)

- FREE DROP OF PACKAGE OVER 9M (30 FT) ONTO FLAT HORIZONTAL ESSENTIALLY UNYIELDING SURFACE
- DYNAMIC CRUSH TEST BY DROPPING SPECIFIED STEEL PLATE WEIGHING 500 KG (1100 LB) OVER 9M (30 FT) ONTO PACKAGE RESTING ON FLAT UNYIELDING SURFACE (TEST ONLY REQUIRED FOR PACKAGES OF SPECIFIED WEIGHT AND DENSITY CONTAINING MORE THAN 1000 TIMES A2 ACTIVITY)
- PUNCTURE TEST BY FREE DROP OF PACKAGE OVER 1M (40") IN MAXIMUM EXPECTED DAMAGE POSITION ONTO UPPER END OF 15 CM (5.9") DIAMETER SOLID VERTICAL STEEL BAR (WITH SPECIFIED TOP EDGE RADIUS AND LENGTH) RESTING ON FLAT HORIZONTAL ESSENTIALLY UNYIELDING SURFACE
- THERMAL EXPOSURE OF PACKAGE BY ENGULFING PACKAGE IN FIRE OF SPECIFIED PARAMETERS AT 800 C (1475 F) FOR 30 MINUTES
- WATER IMMERSION (FISSILE PACKAGES WHERE WATER IN-LEAKAGE NOT ASSUMED IN CRITICALITY EVALUATION) UNDER HEAD OF WATER OF AT LEAST 0.9 M (3 FT) FOR AT LEAST 8 HOURS
- WATER IMMERSION (ALL PACKAGES) OF SEPARATE UNDAMAGED PACKAGE UNDER HEAD OF WATER AT LEAST 15 M (50 FT) AT LEAST 8 HOURS

★ APPLIED IN SEQUENTIAL ORDER TO SAME SPECIMEN

TYPE B PACKAGING

Required when activity exceeds A_1 or A_2

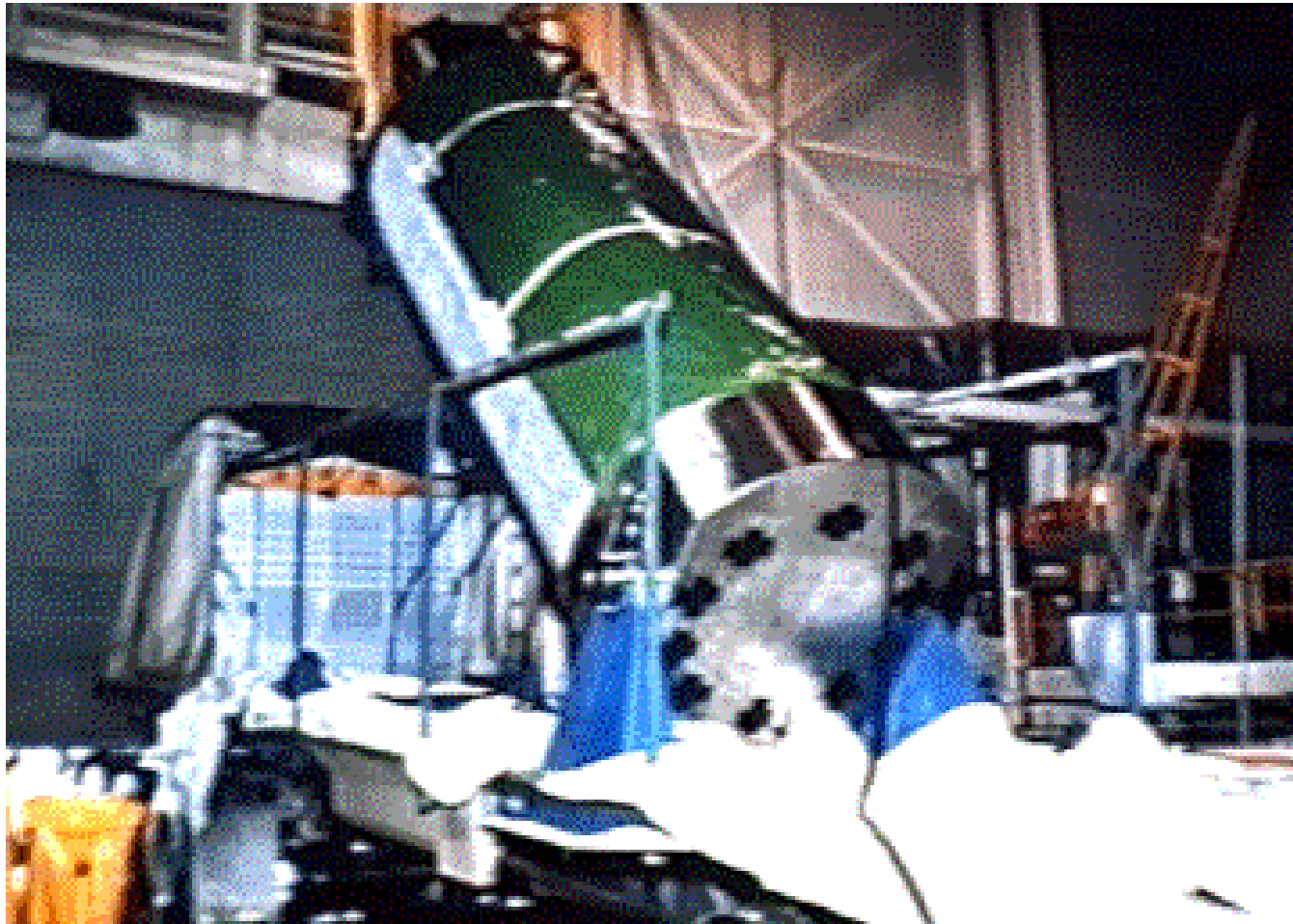
- Packages must meet both normal and accident test conditions
- There are a few DOT Specification Type B packages, e.g, DOT-6M, 20WC, 21WC (173.416(c))-However their use is no longer authorized after October 1, 2008
- Type B Packages of foreign origin may be used for export/import only when foreign certificate is revalidated by DOT (§§173.416(b) & 10CFR71.16)
- Most Type B packages are those certified by NRC pursuant to §§173.416(a) and 10CFR 71.12.
- DOE has independent authority to certify Type B packages pursuant to §173.7(d), *As a practical matter most DOT packages now are certified by NRC, e.g, WIPP, Yucca Mtn packages*
- NRC Document NUREG-0383 is the Directory of Type B packages



PHYS573 13b 30/68

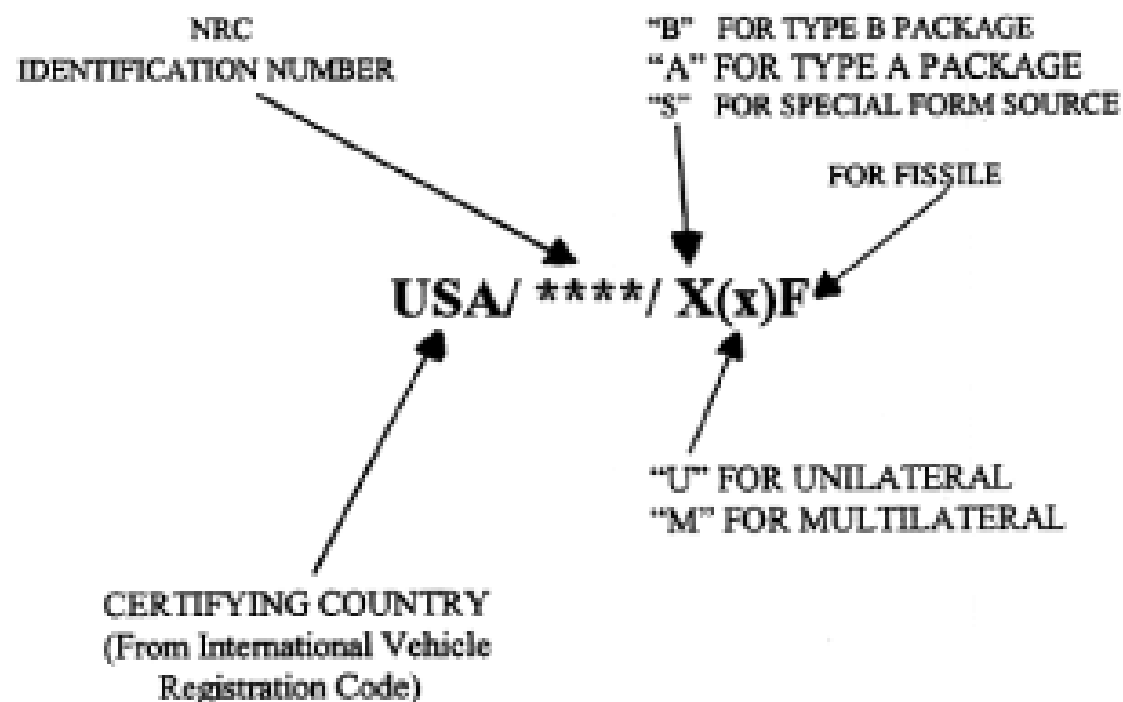


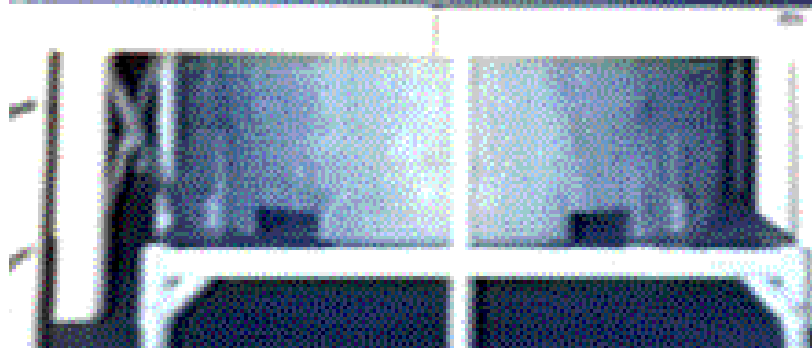
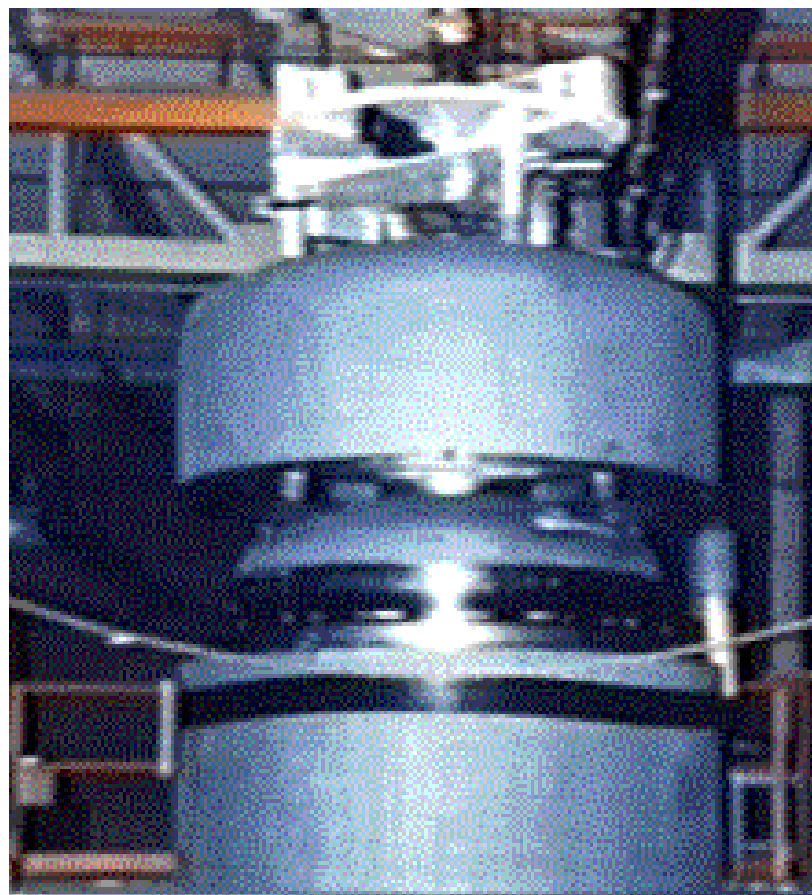
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DOT/NRC NOMENCLATURE FOR PACKAGE AND CERTIFICATE NUMBERING





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FISSILE RADIOACTIVE MATERIALS

TRANSPORT REGULATIONS CONSIDER BOTH:

Radiological safety, e.g. containment
and
Nuclear safety, e.g. criticality control

Typical certified fissile packages are:

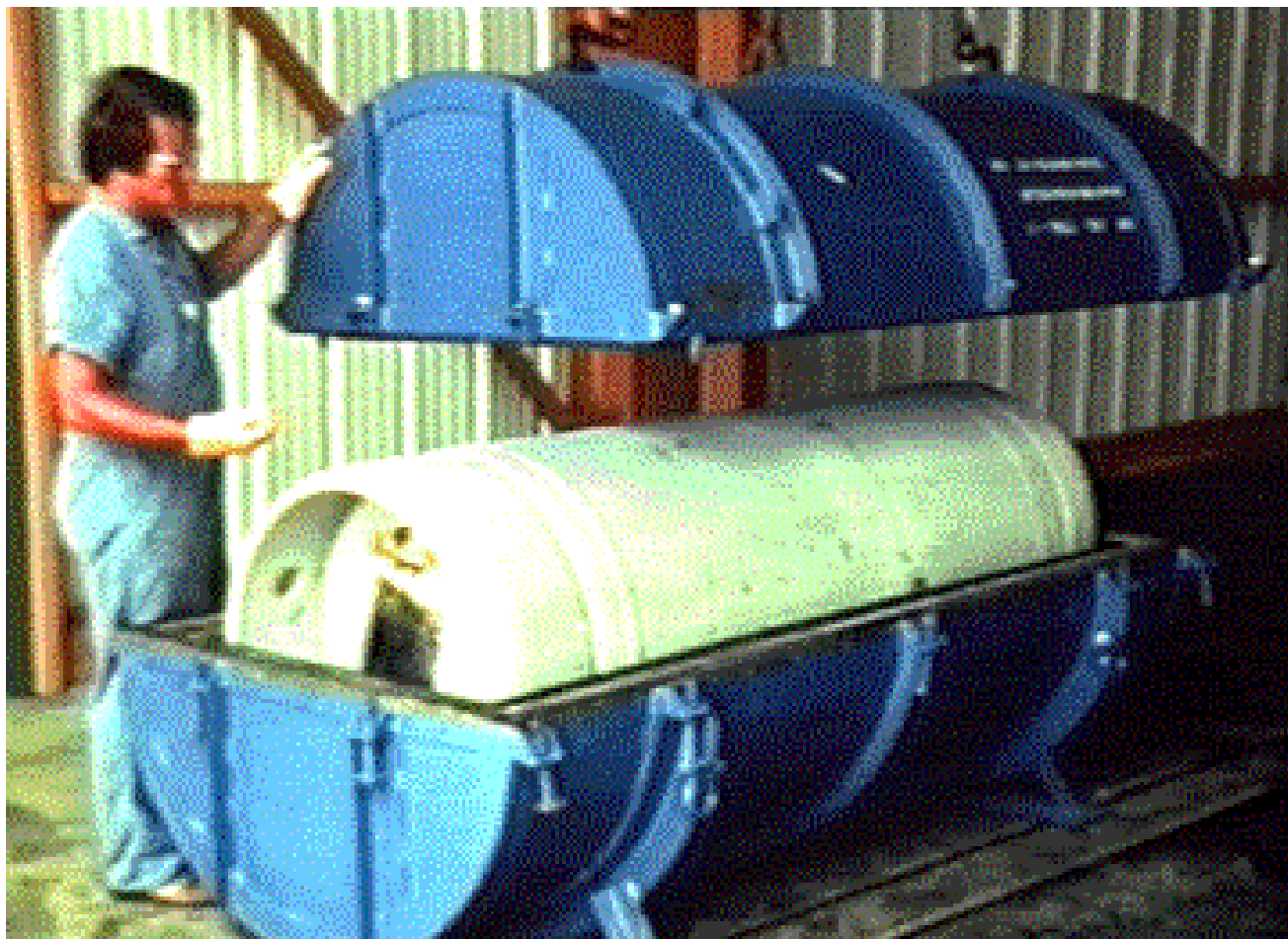
Type AF - unirradiated fresh fuel for power reactors

Type B()F - irradiated, spent reactor fuel

DEFINITION OF FISSILE MATERIAL

§ 173.403

- ***Fissile material*** means plutonium²³⁹, plutonium²⁴¹, uranium²³³, uranium²³⁵ or any combination of these radionuclides. This term does not apply to material containing fissile nuclides, unirradiated natural uranium, or to natural uranium or depleted uranium that has been irradiated in thermal reactors only
- Plutonium²³⁸ has been removed from the definition
- Texts of TS-R-1 and §10 CFR 71.4 slightly differ but mean the same



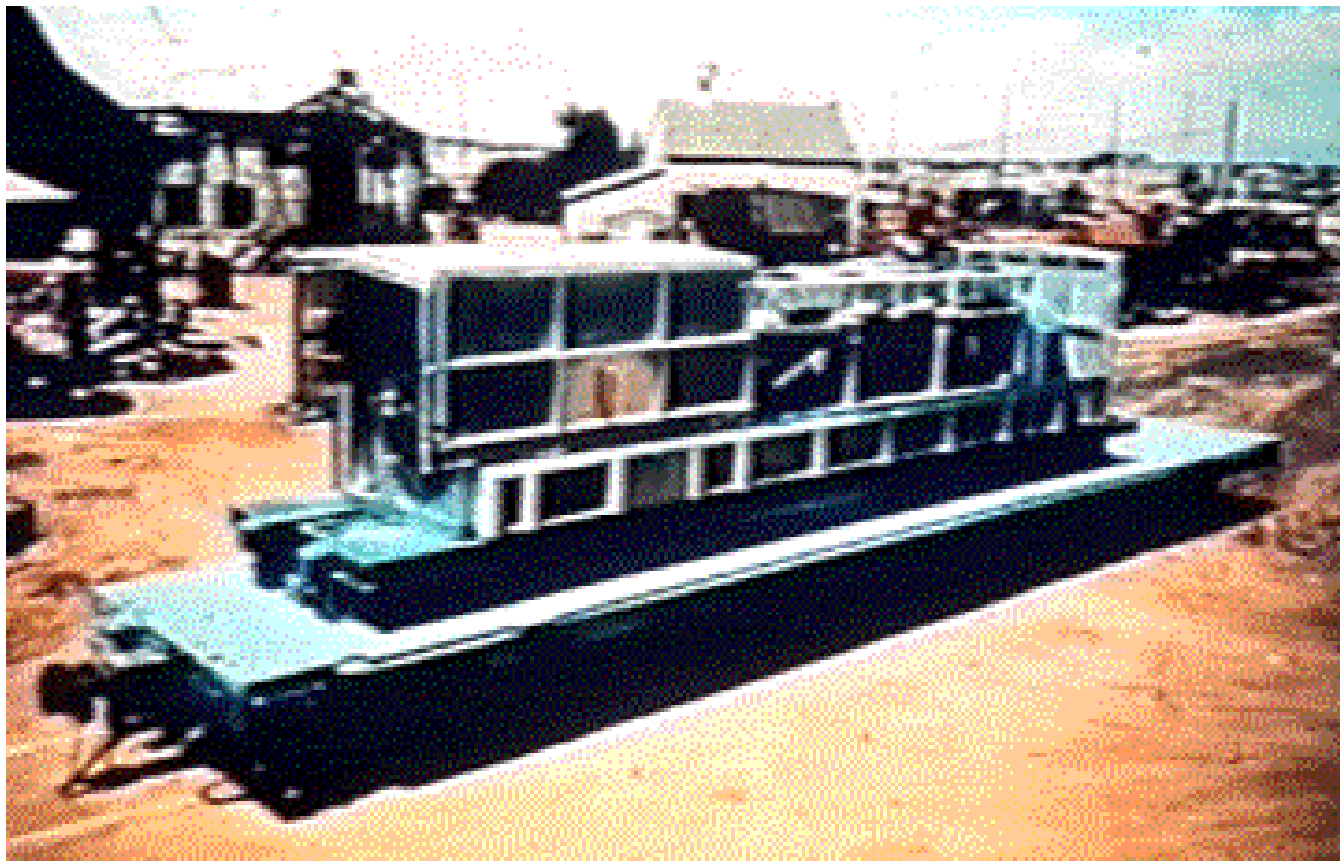
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PHYS573 13b 24/68



PHYS573 13b 25/68



PHYS573 13b 28/68

INDUSTRIAL PACKAGINGS IP-1, IP-2, IP-3

§173.411

- **IP-1 PACKAGING**

Must be only meet design requirements of §173.410

- **IP-2 Packaging**

must meet design requirements of §173.410 and also the Type A packaging free drop and crush tests of §173.465 (c) and (d)

- **IP-3 Packaging**

Must meet design requirements of IP-1 and IP-2 and in addition must meet Type A test requirements of §173.412 (a) through (j)
IP-3 therefore does not have to meet Type A design requirements for liquids [§173.412 (k)]

IM 101 or IM 102 intermodal portable tanks and freight containers may be qualify as IP-3 when specified qualifications and ISO standards are met

- ***For IP-2 and IP-3 Packaging, shipper must maintain a safety analysis report on file documenting the testing and analysis showing that design meets the specifications***

10 49

LOW SPECIFIC ACTIVITY (LSA)

§173.403

- Limited by specific activity of contents into three groups:

LSA-I

LSA-II

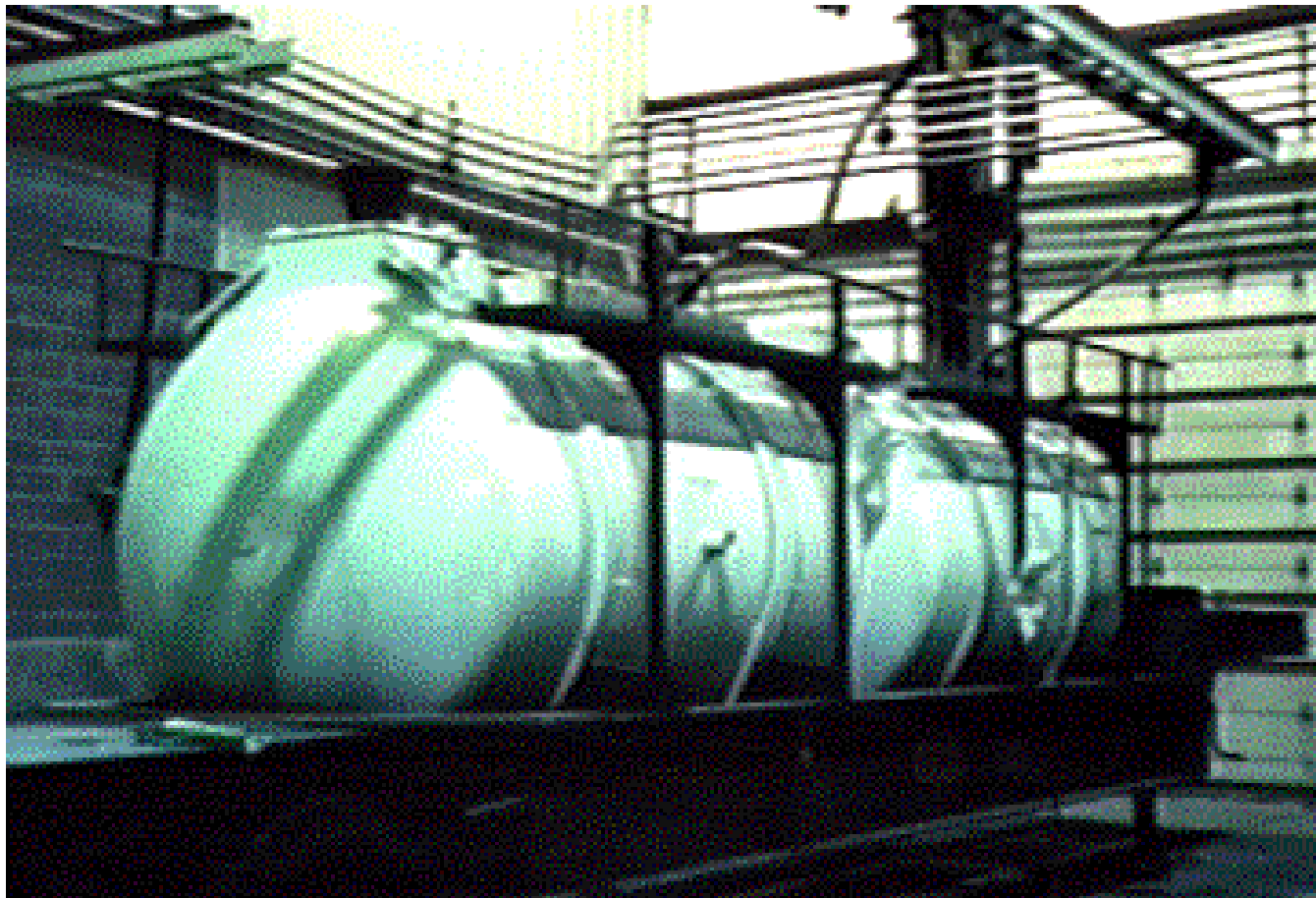
LSA-III

Shielding materials surrounding the LSA material may NOT be considered in determining the average specific activity of the package contents , and ;

During transport, external dose rate may not exceed an external radiation level of 10 mSv/h (1 rem/h) at 3 meters from the UNSHIELDED material

LSA I

- *U and Th Ores, concentrates of U and Th and other natural ores used for processing to remove naturally occurring nuclides*
- *Solid Unirradiated nat or depleted U and nat Th or their liquid or solid compounds/mixtures*
- *Non-fissile Material with Unlimited A_2*
- *Other RAM , except fissile in quantities not excepted under §173.453, if activity is distributed throughout and estimated specific activity does not exceed 30 times the activity concentration values of §173.436 or 30 times default values of Table 10B of §173.433*



LSA-II

- *Water with tritium concentration up to 0.8 TBq/L (20 Ci/L; or*
- *Other radioactive material in which the activity is distributed throughout and estimated activity does not exceed 10^{-4} A₂/gram for solids and gases and 10^{-5} A₂/gram for liquids*



PHYS573 13b 41/68

LSA-III

Solids, such as consolidated wastes, activated materials, excluding powders, that meet the test requirements Of §173.468, in which:

- The activity is distributed throughout a solid or a collection of solid objects; or is essentially uniformly distributed in a solid compact binding agent (bitumin, ceramic, etc);*
- The material is relatively insoluble such that solute (leachate) from unpackaged material in water for 7 days would not exceed $0.1 A_2$; and*
- Estimated average specific activity of solid material, excluding shielding not to exceed $2 \times 10^{-3} A_2/\text{gram}$*

10[

SURFACE CONTAMINATED OBJECTS (SCO)
§173.403

Means A solid object which is not itself radioactive but has radioactive material distributed on its surfaces. SCO exists in the two categories:

SCO-I

SCO-II

DEMARCATIION BETWEEN DOT VS. NRC PACKAGING REQUIREMENTS

$\leq A_1$ or A_2	$> A_1$ or A_2
DOT	NRC
Excepted Quantities	Type B Quantities
Type A Quantities	Type B HRCQ
	Fissile Material

Note: The regulatory agency for LSA and SCO is determined by the radiation level at 3 meters. This is based on 10 mSv/h at 3 meters from the unshielded material, and is referenced in 49 CFR 173.427(a)(1) and 173.427(e).

RECAP & SUMMARY OF MAJOR HM-230 AMENDMENTS Slide 1

- Former definition of "Radioactive material" (70 Bq/g) is deleted
- New definition of "Radioactive material" now based on nuclide-specific exempt activity concentration values per §173.436
- Exempt consignments now based on activity limits per Table in §173.436 for consignments
- New exception provided for certain naturally occurring RAM if specific activity does not exceed 10 times activity concentration exemption values of §173.436
- Incorporate latest TS-R-1 revisions to A_1 and A_2 values, based on new dosimetric models using ICRP Publication 60 (1990)
- Adopt use of Criticality Safety Index (CSI) replacing TI when formerly based on nuclear criticality values

RECAP OF HM-230 MAJOR AMENDMENTS

Slide 2

- Adopt new Fissile label which provides for entering CSI
- Require excepted packages be marked with applicable 4-digit UN Hazard Identification number
- Require Industrial package marking with IP-1, IP-2, or IP-3
- Require Type A packages be marked with International Vehicle Registration Letters of country of package origin
- Remove Plutonium-238 from definition of fissile material

RECAP OF HM-230 MAJOR AMENDMENTS

Slide 3

- Adopt the TS-R-1 definition of "Contamination" as the basis for exemption from regulation for non-radioactive objects with surface contamination
- Include authorization to transport unpackaged LSA and SCO
- Include authority to use certain qualified tank containers , freight containers and metal intermediate bulk containers as Industrial Packages
- Adopt a new class of LSA-I in which activity is ***distributed throughout*** and estimated average specific activity does not exceed 30 times the activity concentration exemption level

RECAP OF HM-230 MAJOR AMENDMENTS

Slide 4

- Delete the LSA-I category for mill tailings, debris, rubble, etc., with specific activity not exceeding 10^{-6} A2/gram
- Incorporate certain TS-R-1 changes for packages containing not more than 0.1 kg of uranium hexafluoride (UF_6)
- Require UF_6 packages to meet thermal test requirements, prohibit use of pressure relief devices, and certify the packages per TS-R-1
- Revise the fissile material exemption provisions, remove the definition "fissile material controlled shipment", and
- Base nuclear safety control for excl and non-excl use fissile package shipments on TS-R-1 package and conveyance limits

RECAP OF HM-230 MAJOR AMENDMENTS

Slide 5

- Accept IAEA transitional ("grandfather") provisions for packages certified under earlier standards
- Begin the phaseout of packages certified previously under the 1967 IAEA Safety Series No 6 standards
- Begin the phaseout of use DOT Specification Type B and Type BF packages on 10/01/04 and prohibit further use on 10/01/07
- Add a requirement that the active material in an excepted package as an instrument or article be completely enclosed by the non-active components

SOME OF THE MAJOR 10CFR71 AMENDMENTS

**NOT an exhaustive list-refer to 69 FR 3698, Vol III, 1/26/04
Statement of Considerations for exhaustive list and discussion**

- NRC did NOT adopt concepts of Type C package and Low Dispersible Materials (LDM) for packages of Plutonium transported by air because present NRC requirements are more rigorous than TS-R-1
- Deleted the "double containment" requirements for plutonium packages
- Began the phaseout of general license authorization to use the few DOT Specification Type B and B(F) packages, as well as packages certified against the 1967 IAEA Safety Series 6 standards
- Significantly amended the four general licenses to use schedule quantities of non-excepted fissile materials
- Adopted deep immersion test for Type B packages with $> A_2$ activity

DOT TRANSPORTATION SECURITY

49 CFR PART 172 SUBPART I

By 9/25/03 persons offering for transportation in commerce one or more of the following must develop and adhere to a security plan:

- ***HRCQ of Radioactive Material;***
- More than 25 Kg of an explosive
- More than 1 liter/package of a material toxic by inhalation;
- HazMat in bulk package >13.2 liters liquids or gases, > 468 cu ft for solids
- ***In other than bulk package a quantity of 2268 kg gross weight of one or more HazMat for which placarding is required;***
- Selected agents or toxins regulated by CDC under 42 CFR 71
- ***Any quantity of a HazMat that requires placarding***

NOTE: "SMALL SHIPPERS" EXEMPT-See DOT Docket HM-232

REMINDEES

- DOT's final amendments to harmonize with TS-R-1 were published in Part II of the Jan 26, 2004 *Federal Register* , Volume 69 No. 16 at page 3632
- NRC's final amendments to harmonize with TS-R-1 were published in Part III of the same Federal Register at page 3698
- Voluntary compliance with both Agencies' amendments was authorized on 2/25/04. *Mandatory compliance was October 1, 2004*





U.S. Nuclear Regulatory Commission

Radiation Protection Program Management: Perspectives of an NRC Regulator

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U.S. Nuclear Regulatory Commission

Creation by Legislation

- Atomic Energy Act (AEA) of 1946
 - Military aspects of nuclear material
 - Joint Committee on Atomic Energy
- Atomic Energy Commission
 - Atomic Energy Act of 1954
 - commercial use of nuclear material
 - continue weapons program
 - promote private use
 - maintain public health and safety



U.S. Nuclear Regulatory Commission

Creation by Legislation (con't)

- Uranium Mill Tailings Radiation Control Act of 1978
 - Stabilize tailings to prevent or minimize hazards
- Nuclear Waste Policy Act of 1982
 - Siting and completing final disposal of high-level radioactive waste
- Low-Level Radioactive Waste Policy Amendments Act of 1985
 - States given responsibility to dispose of own waste
 - States given authority to form waste compacts



U.S. Nuclear Regulatory Commission

Creation by Legislation (con't)

- National Environmental Policy Act of 1969
 - Federal agencies share and coordinate responsibility of risks to the environment
- Energy Reorganization Act of 1974 - Couples with the AEA
 - Split AEC into
 - Energy Research and Development Administration (later DOE) to promote energy independence
 - NRC to license and regulate nuclear facilities



U.S. Nuclear Regulatory Commission

Creation by Legislation (con't)

- Other Legislation effecting NRC
 - Administrative Procedures Act of 1946
 - Nuclear Non-Proliferation Act of 1978
 - West Valley Demonstration Project Act of 1980
 - Nuclear Waste Policy Amendments Act of 1987
 - Energy Policy Act of 1992
 - Federal Reports Elimination and Sunshine Act of 1995



U.S. Nuclear Regulatory Commission

Mission of the NRC

- License and regulate the Nation's civilian use of byproduct, source, and special nuclear materials to ensure adequate protection of public health and safety, promote common defense and security, and protect the environment.



U.S. Nuclear Regulatory Commission

Structure of the NRC

- Headed by five Commissioners (“the Commission”)
 - Appointed by the President
 - Confirmed by the Senate
 - 5-year terms
 - “independent agency”
 - Chairman designated by the President
- Executive Director for Operations (EDO)
 - Chief operational and administrative officer for “the staff”
 - Carries out the policies and decisions of the Commission



U.S. Nuclear Regulatory Commission

Structure of the NRC (con't)

- NRC Offices under the EDO
 - Deputy Executive Director for Materials, Research, State and Compliance Programs
 - Office of Nuclear Material Safety and Safeguards (NMSS)*
 - Office of Nuclear Regulatory Research (RES)*
 - Office of State and Tribal Programs
 - Deputy Executive Director for Reactor and Preparedness Programs
 - Officer of Nuclear Reactor Regulations (NRR)*
 - Regional Offices (Regions I – IV)
 - Office of Enforcement (OE)
 - Officer of Nuclear Safety and Incident Response (NSIR)
 - » * Statutory requirement



U.S. Nuclear Regulatory Commission

Structure of the NRC (con't)

- NRC Offices
 - White Flint, Rockville, Maryland
 - NRC Regional Offices
 - Region I King of Prussia, Pennsylvania
 - Region II Atlanta, Georgia
 - Region III Lisle, Illinois
 - Region IV Arlington, Texas



U.S. Nuclear Regulatory Commission

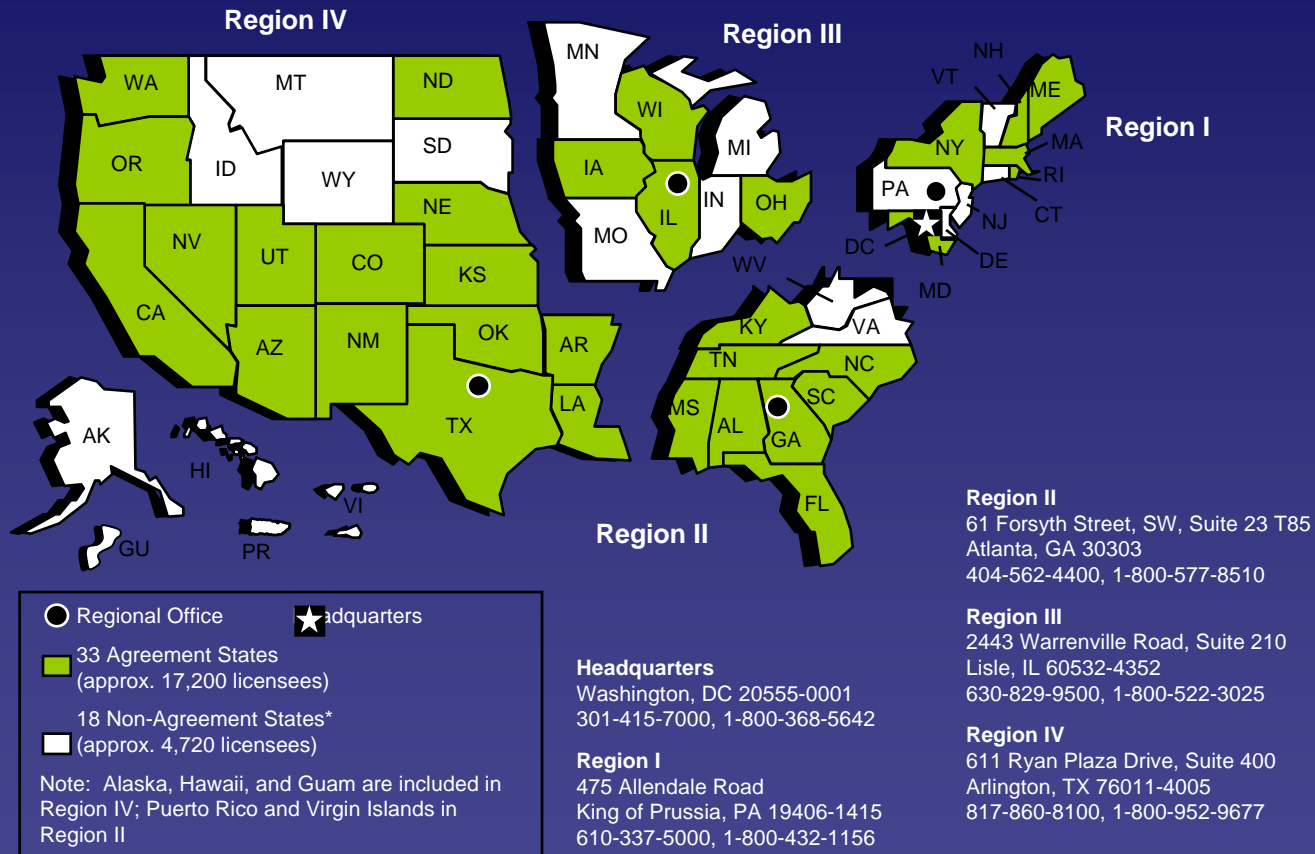
Structure of the NRC (con't)

- Who regulates the activity
 - Federal Agencies regardless of location
 - Except for DOE and prime contractors- NRC
 - Non-Federal entity in non-Agreement State - NRC
 - Non-Federal entity in Agreement State - Agreement States
 - About 4,000 NRC licensees; 16,000 Agreement State licensees



U.S. Nuclear Regulatory Commission

Locations of NRC Offices and Agreement States



* The 18 Non-Agreement States include the District of Columbia and two states that have filed letters of intent: Minnesota and Pennsylvania.



Structure of the NRC (con't)

- Agreement States
 - Enter agreement with NRC to assume authority to regulate
 - States must demonstrate adequacy of program to protect public health and safety
 - State must demonstrate that program is compatible
 - Currently 33 Agreement States
 - Approximately 16,000 licenses
 - Compared to about 4,000 licensed by NRC



U.S. Nuclear Regulatory Commission

Jurisdiction

- NRC has authority over
 - Byproduct material
 - Radioactive material yielded in or made by a reactor; tailings or waste produced by extraction or concentration of uranium
 - Source material
 - Uranium or thorium or their ores containing 0.05 per cent or more by weight
 - Special Nuclear Material
 - Plutonium, uranium-233, uranium enriched with U-233 or U-235, or any other material determined to be special nuclear material



U.S. Nuclear Regulatory Commission

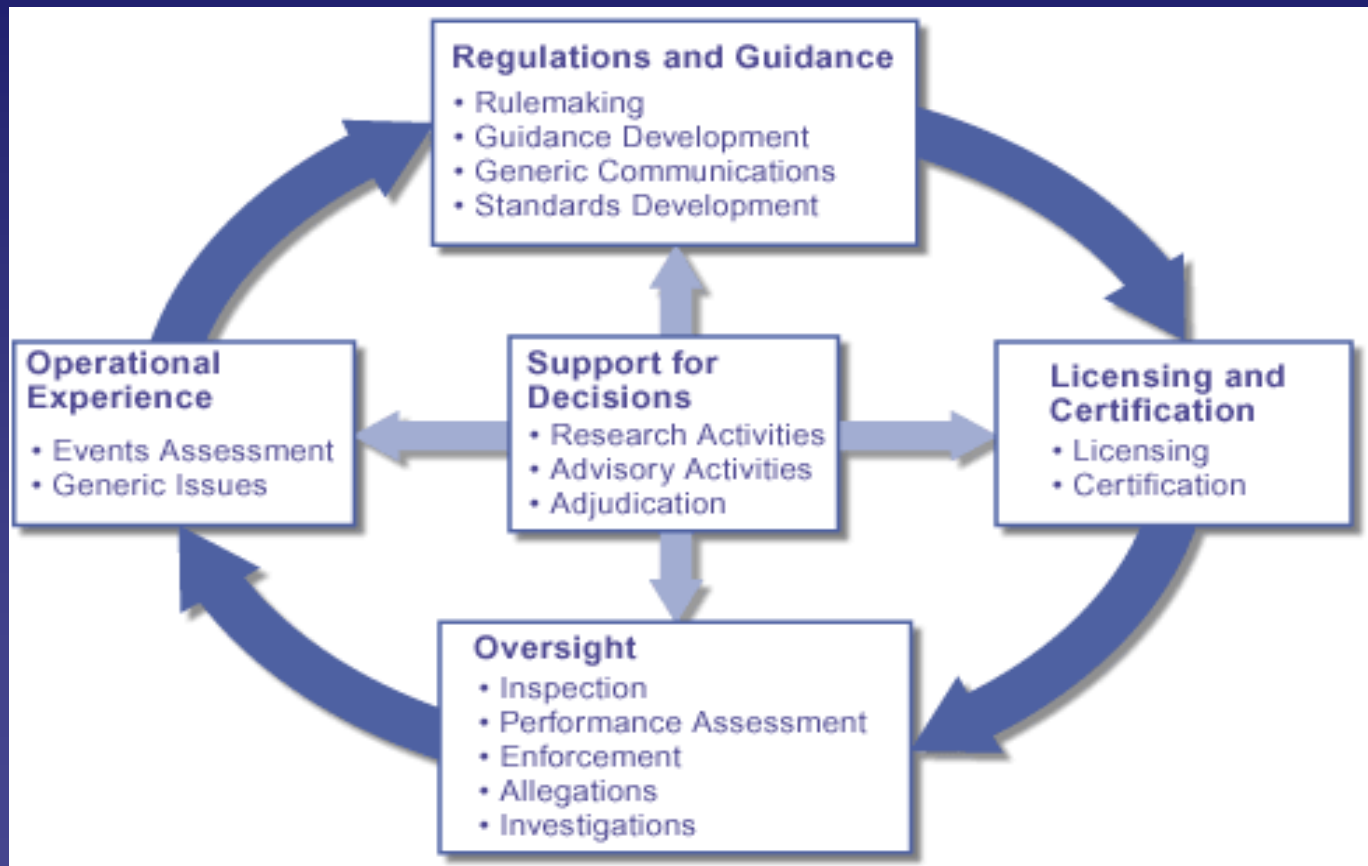
Nuclear Material Oversight Program

- Mission
 - License and regulate the Nation's civilian use of byproduct, source, and special nuclear materials to ensure adequate protection of public health and safety, promote common defense and security, and protect the environment
- Program
 - Industrial and medical nuclear safety
 - Fuel cycle safety and safeguards
 - Waste Management
 - Spent fuel storage, transportation, and disposal
 - Commercial reactors



U.S. Nuclear Regulatory Commission

Nuclear Material Oversight Program





U.S. Nuclear Regulatory Commission

Nuclear Material Oversight Program (con't)

- NRC manages and oversees the programs, and interacts with licensees, by
 - Regulations
 - Licensing
 - Inspections
 - Enforcement



U.S. Nuclear Regulatory Commission

Regulations

- Origin of idea for a new rule
 - Commission
 - Staff
 - Individual
- Advanced Notice of Proposed Rule
 - Solicitation for comment from the public
 - Staff addresses comments, develops a proposed rule
 - Proposed rule sent to Commission for approval



U.S. Nuclear Regulatory Commission

Regulations (con't)

- Proposed Rule
 - Published in the *Federal Register* for public comment
 - Comment period at least 75 days
- Final rule
 - Staff addresses comment, drafts final rule
 - Final rule sent to Commission for approval
 - Published with an effective date, usually 30 days
- Time – about 3 years from initiation to final rule



U.S. Nuclear Regulatory Commission

Regulations (con't)

- Rules and Regulations
 - Title 10 – Chapter 1, Code of Federal Regulations - Energy
 - Parts 0 to 199 are NRC regulations
 - Title 10 CFR
 - Part 19 – Notices, Instructions and Report to Workers: Inspections and Investigation
 - Part 20 – Standards for Protection Against Radiation
 - Part 33 – Specific Domestic Licenses of Broad Scope for Byproduct Material
 - Part 36 – Licenses and Radiation Safety Requirements for Irradiators



Licensing

- Types of licensing
 - General licenses
 - Sources and devices that are designed to limit personnel exposure
 - No need for an application, may need to register
 - Specific licenses
 - Limited scope
 - Broad scope



U.S. Nuclear Regulatory Commission

Licensing (con't)

- Specific License of Limited Scope
 - Specifically defines and authorizes
 - Type of radionuclide
 - Amount of radionuclide
 - Specific use of material
 - Specific users of material
 - Limiting conditions
 - Based on review of application
 - Training and experience
 - Facilities
 - Procedures, Radiation Safety Program



U.S. Nuclear Regulatory Commission

Licensing (con't)

- Specific License of Broad Scope
 - Licensee has greater flexibility for material, users, uses
 - Licensee must have
 - Considerable experience under limited scope
 - Good performance record under previous license
 - Three Types of Broad Scope A, B, and C
 - Type A most flexible
 - Atomic number 1 – 83
 - Any chemical or physical form
 - Multi-curie quantities
 - Must have a Radiation Safety Committee
 - » RSO, management, and users



U.S. Nuclear Regulatory Commission

Licensing (con't)

- Three Types of Broad Scope (con't)
 - Type B less flexible than A
 - Atomic number 1 -83
 - Any chemical or physical form
 - Possession limited to quantities in 10 CFR 33.100 Schedule A, Column I (curie quantities) plus unity rule
 - Controlled by an RSO
 - Type C less flexible than B
 - All the above for Type B but
 - Possession limited to quantities in 10 CFR 33.100 Schedule A, Column I I (tenths of curie quantities) plus unity rule



U.S. Nuclear Regulatory Commission

Licensing (con't)

- Limited Scope
 - Must have specific license of limited scope for
 - Tracer studies in the environment
 - Acquire more than 100,000 curies for irradiators
 - Industrial radiography
 - Human use of medical isotopes
 - Manufacture and distribute sources and devices
 - Add byproduct material to food, beverage, cosmetics, drugs or other products designed to inhale or ingest by a human



U.S. Nuclear Regulatory Commission

Licensing (con't)

- How to apply for a license
 - Complete an NRC Form 313
 - Submit original and one copy with supporting documents
 - Training
 - Facilities with drawings
 - Safety program
 - Submit to the Regional Office for your locale (or Agreement State if applicable)
 - Send fee as per 10 CFR 170.11
 - (there are also annual fees per 10 CFR 171.16)



U.S. Nuclear Regulatory Commission

Licensing (con't)

- Things to consider in an application
 - Indicate items that you are willing to do or get
 - Ask for radionuclides that you will use and need
 - Possession limit
 - Emergency plan if offsite doses can exceed 1 rem TEDE or 5 rem thyroid
 - Financial assurance for decommissioning (10 CFR 30, Schedule B)
 - Field and animal studies may need an Environmental Assessment



U.S. Nuclear Regulatory Commission

Licensing (con't)

- Consolidated Guidance About Material Licenses NUREG-1556
 - Vol. 1 -Program-Specific Guidance About Portable Gauge Licenses
 - Vol. 4 - Program-Specific Guidance About Fixed Gauge Licenses
 - Vol. 5 - Program-Specific Guidance About Self-Shielded Irradiator Licenses
 - Vol. 6 - Program-Specific Guidance About 10 CFR Part 36 Irradiator Licenses
 - Vol. 7 - Program-Specific Guidance About Academic, Research and Development, and Other Licenses of Limited Scope Including Gas Chromatographs and X-Ray Fluorescence Analyzers
 - Vol. 11 - Program-Specific Guidance About Licenses of Broad Scope



U.S. Nuclear Regulatory Commission

Licensing (con't)

- License
 - Must be received before receiving radioactive material
 - Sent to licensee after review of application, approval, and fees are paid
 - Issued for 10 years
 - Some are hand delivered, others facilities receive first visit within 6 months



U.S. Nuclear Regulatory Commission

NRC FORM 374

U.S. NUCLEAR REGULATORY COMMISSION

PAGE 1 OF 3

MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 36, 39, 40, and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee			
1. Academic, R&D Other Labs, Inc.		3. License number 99-12345-01	
2. 999 Research Boulevard		4. Expiration date May 31, 2008	
Universityville, Any State 98765		5. Docket No. 030-56789 Reference No.	
6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license	
A. Nickel-63	A. Foils or plated sources registered either with NRC under 10 CFR 32.210 or with an Agreement State and incorporated in a compatible gas chromatograph as specified in Item 9 of this license	A. No single source to exceed the maximum activity specified in the certificate of registration issued by the U.S. Nuclear Regulatory Commission or an Agreement State	
B. Hydrogen-3	B. Foils registered either with NRC under 10 CFR 32.210 or with an Agreement State and incorporated in a compatible gas chromatograph as specified in Item 9 of this license	B. No single source to exceed the maximum activity specified in the certificate of registration issued by the U.S. Nuclear Regulatory Commission or an Agreement State	
9. Authorized use			
A. and B. To be used for sample analysis in compatible gas chromatography devices that have been registered either with NRC under 10 CFR 32.210 or with an Agreement State and have been distributed in accordance with an NRC or Agreement State specific license authorizing distribution to persons specifically authorized by an NRC or agreement State license to receive, possess, and use the devices.			



U.S. Nuclear Regulatory Commission

Licensing (con't)

NRC FORM 374A	U.S. NUCLEAR REGULATORY COMMISSION	PAGE 2 OF 3 PAGES
MATERIALS LICENSE SUPPLEMENTARY SHEET		License Number 99-12345-01
		Docket or Reference Number 030-56789
<p>11. A. Licensed material shall be used by, or under the supervision of, P. Sellers, Ph.D., J. Lemmon, Ph.D., or W. Matthau, M.S.</p> <p>B. The Radiation Safety Officer for this license is W. Matthau, M.S.</p> <p>12. Detector cells containing licensed material shall not be opened or the foil sources removed from the detector cell by the licensee.</p> <p>13. A. Sealed sources shall be tested for leakage and/or contamination at intervals not to exceed the intervals specified in the certificate of registration issued by the U.S. Nuclear Regulatory Commission under 10 CFR 32.210 or under equivalent regulations of an Agreement state.</p> <p>B. In the absence of a certificate from a transferor indicating that a leak test has been made, within the intervals specified in the certificate of registration issued by the U.S. Nuclear Regulatory Commission under 10 CFR 32.210 or under equivalent regulations of an Agreement state, prior to the transfer, a sealed source received from another person shall not be put into use until tested and the test results received.</p>		



U.S. Nuclear Regulatory Commission

Licensing (con't)

23. Except as specifically provided otherwise in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents, including any enclosures, listed below. The Nuclear Regulatory Commission's regulations shall govern unless the statements, representations, and procedures in the licensee's application and correspondence are more restrictive than the regulations.

A. Application dated April 12, 1998

B. Letter dated May 5, 1998

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Date: (insert license issue date)

By: (insert reviewer's name) (Original signed by)

NRC License Reviewer

Nuclear Materials Licensing Branch



U.S. Nuclear Regulatory Commission

Inspections

- Types of inspections
 - Routine
 - Interval commensurate with hazard; 1, 2, 3, and 5 year intervals
 - Reactive
 - Special inspection responding to an incident, allegation, or special information
 - Usually focused, does not satisfy for routine
 - Team
 - Three or more inspectors, or outside agency



U.S. Nuclear Regulatory Commission

Inspections (con't)

- Who inspects
 - Inspector from Regional Office
 - Inspector who may or may not have performed application review
 - Inspector who has reviewed licensee file
 - License and license application
 - Past inspections
 - Past communication notes, commitments, significant actions
 - Past incidents, allegations



U.S. Nuclear Regulatory Commission

Inspections (con't)

- When are inspections
 - Within the prescribed frequency interval, or sooner
 - Unannounced, sometime within inspection interval
 - During normal working hours
 - Will take opportunity to see after-hour operations
- Where are inspections
 - At the licensee's facility
 - Inspector should have unrestricted access to where licensed material is being used or exposure could occur
 - Remote or temporary sites



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Inspections (con't)

- What is inspected
 - Security and control of licensed material
 - Shielding of license material
 - Comprehensive safety measures
 - Radiation dosimetry program
 - Radiation instrumentation and surveys
 - Radiation safety training and practices
 - Management oversight



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Inspections (con't)

- Why are inspections conducted
 - Ensure that activities meet
 - NRC regulations
 - license conditions
 - application commitments (tie-down conditions)
 - Ensure mission is being accomplished
 - Protect public health and safety
 - Common defense and security
 - Protect the environment



Inspections (con't)

- How an inspection is conducted
 - Performance-based approach
 - Direct observation of work activities
 - Interviews with licensees workers
 - Demonstrations by appropriate workers
 - Independent measurements
 - Review of selected records for verification
 - Look for assurances of ability to safely use licensed material



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Inspections (con't)

How an inspection is conducted (con't)

- Look at facility since last inspection
- Get a feel for the safety culture of the facility
- Common elements of inspections
 - Entrance meeting with management representative
 - Purpose and scope of inspection
 - Provide a tentative schedule
 - Identify persons to be interviewed
 - Chance for licensee to identify any problems



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Inspections (con't)

How an inspection is conducted (con't)

- Follow up on previous inspection findings
 - Corrective action of cited violations
- General overview
 - Organization
 - Personnel changes, functions, reporting relationship
 - Scope of program
 - Types, quantities, and use of licensed material



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Inspections (con't)

How an inspection is conducted (con't)

- Observation of actual facilities and activities
 - Walk-through to make general observations
 - Look at operations that are dose contributors
- Independent and confirmatory measurements
 - Measurements with and without comparison
 - Restricted, controlled, and unrestricted areas



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Inspections (con't)

How an inspection is conducted (con't)

- Special license conditions
 - Unique conditions of practices, procedures, equipment
- Keeps licensee informed of any apparent violations
- Exit meeting
 - Meet with the most senior licensee representatives present
 - Explain, understand, and agree on any cited violations
 - Understand licensee correction plans



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Inspections (con't)

How an inspection is conducted (con't)

- Exit meeting (con't)
 - Prompt action on safety issues or significant requirements
 - Discuss proprietary information
- Post-inspection activities
 - Inspector – supervisor discussion
 - Documentation of the inspection



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Inspections (con't)

- Documentation of Inspection
 - Form 591M – no or minor infractions
 - No violations
 - Non-cited violations
 - Cited violations
 - Formal Report
 - Violations that need corrective action in 30 days
 - Need written response to NRC



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Inspections (con't)

- Inspection Procedures
 - Emphasis on what is inspected
 - control access to and prevent loss of licensed material
 - Security, facilities, receipt and transfer of material, authorized users, source inventory
 - maintain shielding of licensed materials
 - Shielding, area surveys, equipment (glove boxes, shields, etc.)
 - implement comprehensive safety measures to limit other hazards
 - Fire protection, chemical hazards, transportation



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Inspections (con't)

Emphasis on what is inspected (con't)

- implement a radiation dosimetry program
 - Internal and external personnel dosimetry, radiation doses, reports, public doses, ALARA
- provide radiation instrumentation
 - Sufficient numbers, calibration, contamination control, surveys, waste management
- ensure that workers are
 - knowledgeable of safe radiation practices
 - » Part 19 Worker rights, training requirements
 - Skilled in normal and accident situations
 - Empowered to implement radiation safety program



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Inspections (con't)

Emphasis on what is inspected (con't)

- management system should be appropriate for the scope of use
 - Licensee responsible for program
 - Proper delegation of responsibility to RSO
 - Proper involvement for support of program
 - Radiation Safety Committee (Type A Broad scope)
 - Audits
 - » safety program content and implementation is reviewed at least annually (see 10 CFR 20.2102(a)(2))
 - » Is management being briefed?



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Inspections (con't)

- Manuals and guidance
 - Inspection Manual Chapter 2800
 - Inspection Procedures (part of Inspection Manual)
 - 83822 - Radiation Protection
 - 87122 - Irradiator Programs
 - 87124 - Fixed and Portable Gauge Programs
 - 87126 - Industrial/Academic/Research Programs



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Inspections (con't)

- Manuals and guidance (con't)
 - Generic communications
 - Published on as needed basis, sent to licensees
 - Information Notices (IN)
 - » Provides information on recently identified safety issues
 - Regulatory Issues Summary (RIS)
 - » Announces staff technical or policy positions not previously communicated nor broadly understood
 - » Provides clarification



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Enforcement

- Purpose
 - to emphasize the importance of compliance with regulatory requirements
 - to encourage prompt identification, and prompt, comprehensive correction of violations



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Enforcement

- Three primary enforcement sanctions:
 - 1. Notice of Violation (NOV):
 - identifies a requirement and how it was violated, and normally requires a written response
 - Four severity levels, SLIV least severe, SLI most severe
 - Could be on Form 591M or formal report



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Enforcement

- Three primary enforcement sanctions: (con't)
 - 2. Civil Penalties
 - A monetary fine issued under authority of Section 234 of the AEA or Section 206 of the ERA. Section 234 of the AEA provides for penalties of up to \$100,000 per violation per day
 - For Severity Level III and above
 - SLIII and above generates a press release, publication in *Federal Register*, listed on NRC web site



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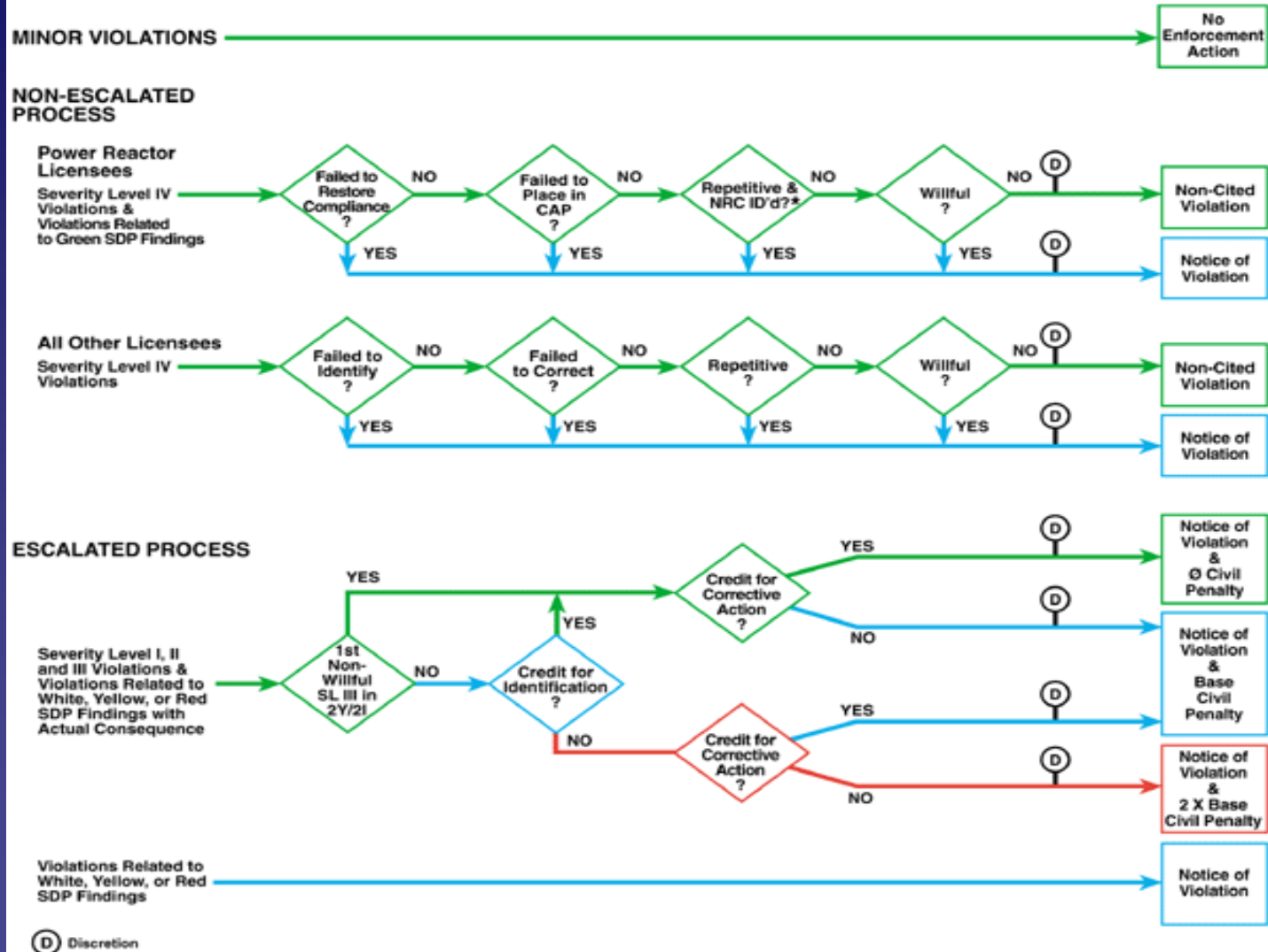
Enforcement

- Three primary enforcement sanctions: (con't)
 - 3. Orders:
 - modify, suspend, or revoke licenses or require specific actions by licensees or persons
 - In lieu of or in addition to civil penalty
 - Can also be issued to non-licensed individual



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NRC ENFORCEMENT PROCESS





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Enforcement

- What Enforcement Process indicates it is
 - Good to self identify violations
 - Good to correct violations
 - Not good to repeat violations
 - Not good to willfully commit violations



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NRC WEB SITE

- <http://www.nrc.gov/>
 - <http://www.nrc.gov/what-we-do.html>
 - <http://www.nrc.gov/materials.html>
 - Describes the different program: medical, industrial, etc)
 - <http://www.nrc.gov/reading-rm.html>
 - Basic references, correspondence
 - <http://www.nrc.gov/reading-rm/doc-collections/>
 - All reference documents available to the public
 - NUREGs, generic communications
 - Inspection manual